





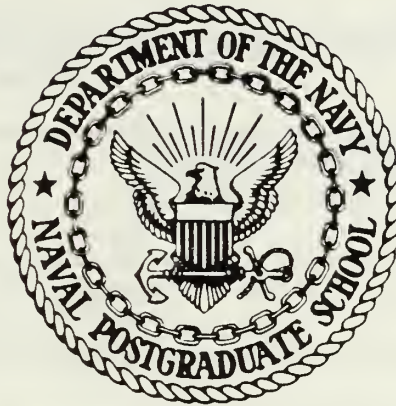


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# NAVAL POSTGRADUATE SCHOOL

## Monterey, California



# THESIS

DEVELOPMENT OF A DATA ACQUISITION SYSTEM TO  
AID IN THE AERODYNAMIC STUDY OF VARIOUS  
HELICOPTER CONFIGURATIONS

by

Patrick A. Witt

March 1986

Thesis Advisor:

Donald M. Layton

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Development of a Data Acquisition System  
to aid in the Aerodynamic Study  
of Various Helicopter Configurations

by

Patrick A. Witt  
Lieutenant, United States Navy  
B.S., United States Naval Academy, 1978

Submitted in partial fulfillment of the  
requirements for the degrees of

MASTER OF SCIENCE IN AERONAUTICAL ENGINEERING  
and  
AERONAUTICAL ENGINEER

from the

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March 1986



## ABSTRACT

This thesis developed a data acquisition system to be used in conjunction with the 3.5' x 5.0' low speed wind tunnel at the Naval Postgraduate School. Interactive graphic programs were developed to aid in data acquisition and analysis. In addition, the internal balance that was designed by Major Scott Mair and Major Chris Sargent was redesigned to correct some problems encountered with the drag component. The balance was also instrumented to record the pitch and yaw moment components. A calibration rig was designed and constructed in order to evaluate the interactions of the different components. The equipment used and programs developed for data acquisition and analysis were adequate. However, balance calibration revealed problems with the calibration rig and location of the roll component strain gage. Both of these problems will have to be corrected before accurate readings can be expected from this balance design.

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## I. INTRODUCTION

### A. BACKGROUND

This project used the 3.5' x 5.0' low speed wind tunnel at the Naval Postgraduate School to continue the aerodynamic study of the effects of helicopter noses and tails on drag conducted by Major Mair [Ref. 1] and Major Sargent [Ref. 2]. Their work included the construction of nine various helicopter configurations, a sting mounted support system and a four-degree-of-freedom balance that was internal to the model. They also studied the airflow around the various configurations with cotton tufting.

To reduce and analyze the data, Majors Mair and Sargent developed several independent computer programs. These programs calibrated the balance, corrected the raw data from the wind tunnel runs, computed the equivalent flat plate area and produced plots of various parameters for comparison. However, due to problems encountered with the drag component of the balance, their results were inconclusive.

### B. GOALS

The primary goal of this project was to provide the students enrolled in the helicopter design class at the Naval Postgraduate School with a laboratory type set-up that would develop realistic Equivalent Flat Plate Area

information for various helicopter configurations. This included creating interactive computer programs that the students could use with the personal computer located at the wind tunnel.

The secondary goals of this project were to upgrade the two-axis internal wind tunnel balance to a six-axis internal balance and to develop a calibration rig to evaluate the interactions of the balance components.

Three landing gear configurations were also designed and constructed for future analysis of the drag that they add to the helicopter.



## II. APPROACH TO THE PROBLEM

### A. LANDING GEAR DESIGN

To provide a realistic representation of landing gear used with modern-day helicopters, one type of landing gear was selected for each nose shape (Figures 2.1-2.3). Planviews for the three types of landing gear were prepared and are included in Appendix A.

For the attack nose, a skid type of landing gear was constructed of aluminum tubing secured to an aluminum plate. This type of landing gear is considered a fixed gear but was chosen because of its wide use for numerous helicopters. For both the smooth nose and blunt nose a simulated retractable gear was constructed of wood stubwings and model airplane tires. Threaded inserts were mounted in the noses and stubwings to allow easy removal of the wheel and strut assemblies. This allowed the models to be tested in both the clean and dirty configuration.

### B. INTERNAL BALANCE MODIFICATION

A modified Mair/Sargent balance, Figures 2.4-2.7, was used for this project.

To improve the output recorded from the axial component, the cuts (see Figure 2.4) alongside that cavity were increased by  $1/16$  of an inch. In addition, the cavity itself was squared off thus reducing the curvature of the

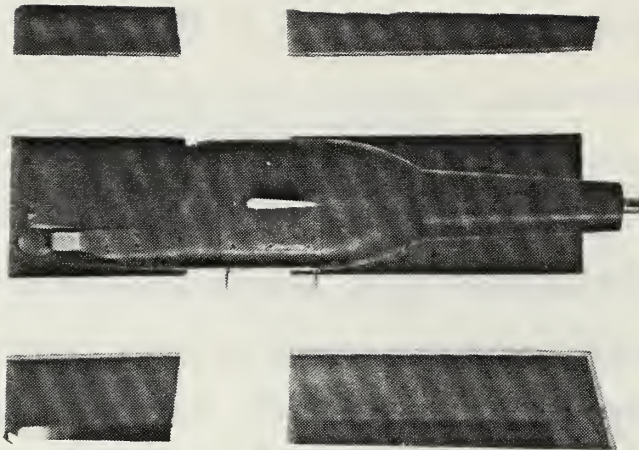


Figure 2.1 Attack Nose with gear

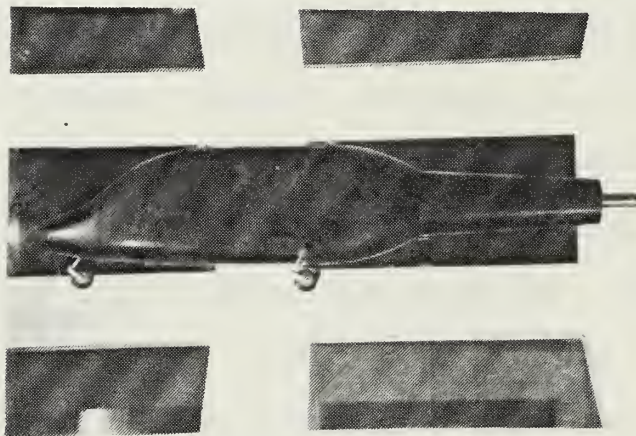


Figure 2.2 Smooth Nose with gear

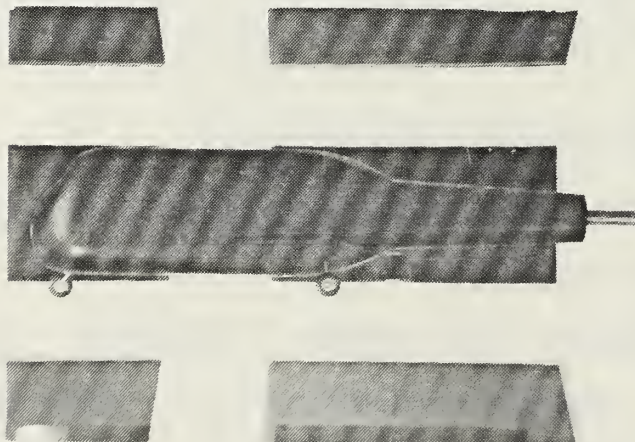


Figure 2.3 Blunt Nose with gear

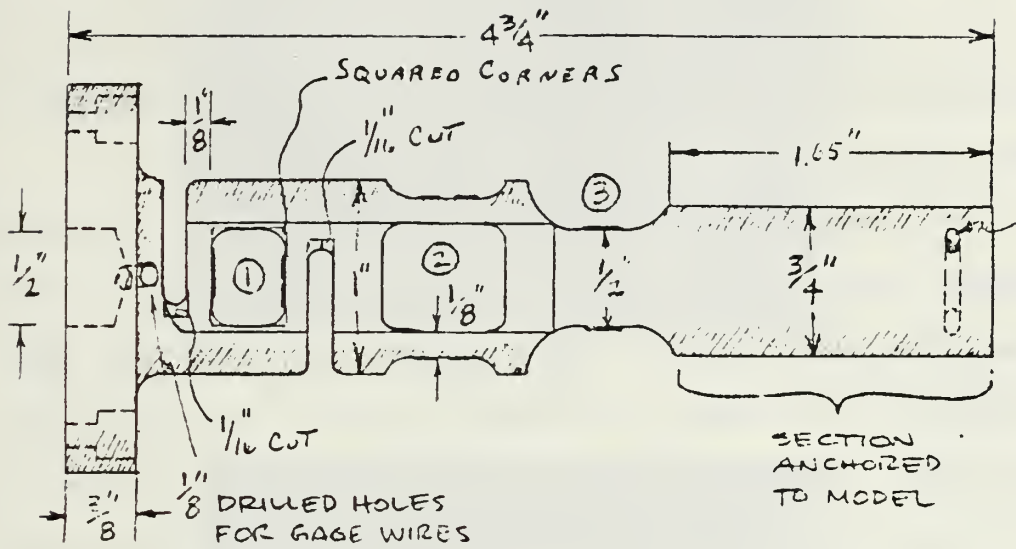


Figure 2.4 Internal Balance with Modifications

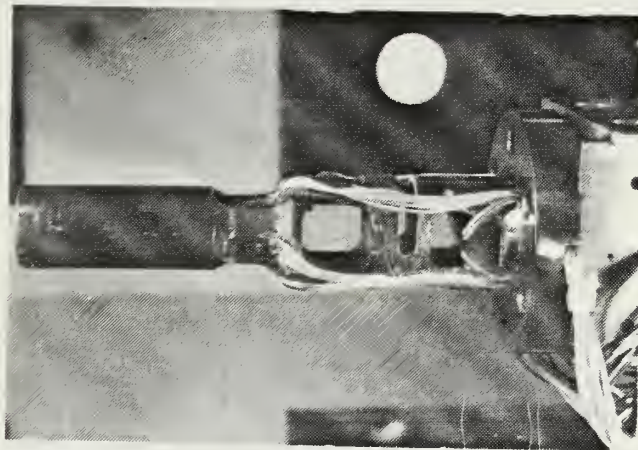


Figure 2.5 Re-Wired Internal Balance

surfaces in the cavity. These modifications increased the flat area upon which the strain gages could be placed.

An area (see Figure 2.6), similar to that for the pitching moment component, was cut to allow recording of the yawing moment component.

For compatability and increased accuracy, the aluminum strain gages were removed and replaced by EA-09-062AQ-350 stainless steel ones. These gages were smaller and thus allowed for better placement within the cavities. To provide a longer life, the gages were bonded to the balance with an M-Bond AE-15 adhesive system. They were cured at a temperature of 150 degrees Fahrenheit for two hours.

It was desired to record the six component forces on the helicopter; lift, drag, yaw, pitching moment, yawing moment and rolling moment. However, since the internal balance was designed to record only four components, the sting support was instrumented to record the yaw force and rolling moment (Figure 2.8).

The gages for the yaw component were placed on the side of the sting support to undergo tension and compression when subjected to a yawing force. The gages for the rolling moment component were placed on top and bottom of the sting support at a 45 degree angle to the sting axis. Thus, they experienced tension and compression when the model was subjected to a rolling moment.



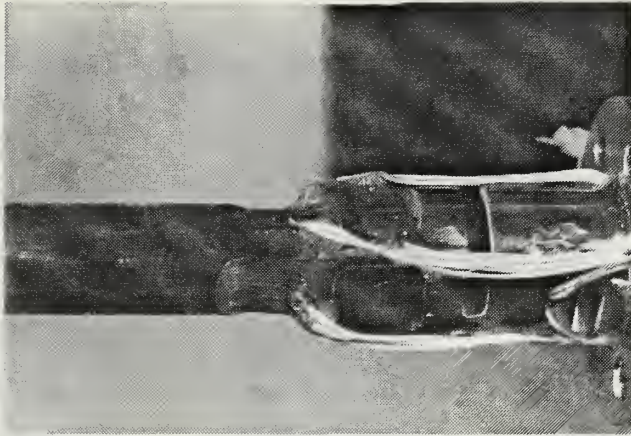


Figure 2.6 Lift, Pitch Moment and Yaw Moment Gages

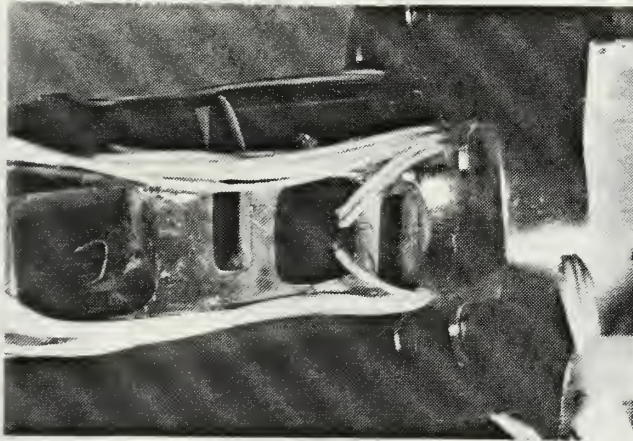


Figure 2.7 Drag Component Gage

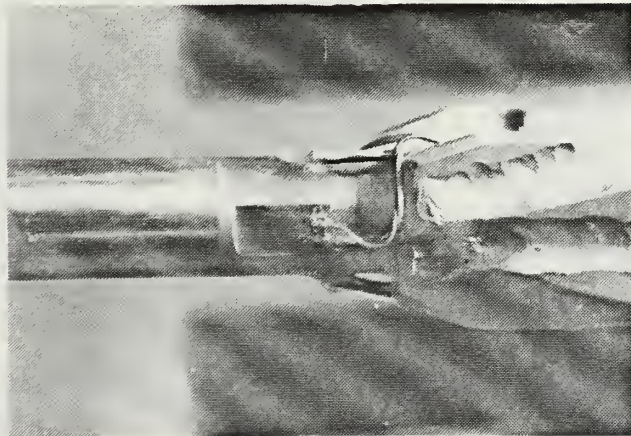


Figure 2.8 Yaw and Roll Moment Gages

### C. BALANCE CALIBRATION

In order to determine any interaction between the six recording components, a calibration rig was designed and mounted to the main fuselage (Figure 2.9). The pans and pulleys were arranged to simulate the twelve forces and moments that the helicopter models would experience in the wind tunnel. Each pan, or component was loaded from zero to twenty pounds in one pound increments. With each loading, readings from the other five components were recorded. This method was conducted until all six components were loaded in both the positive and negative direction and produced thirty interaction matrices.

A balance calibration program, Figure A.16, was written to determine the relations required to convert the raw data counts to actual forces and moments. For each component loading, the prime gage constants were determined using the following least squares curve fit [Ref. 3]:

$$[\text{Sum}(X_i)^2] * K_1 + [\text{Sum}(X_i^3)] * K_2 = \text{Sum}(X_i * Y_i)$$

$$[\text{Sum}(X_i)^3] * K_1 + [\text{Sum}(X_i^4)] * K_2 = \text{Sum}((X_i^2) * Y_i)$$

where  $X_i$  is the raw data count  
and  $Y_i$  is the applied load

Once these constants were computed for all twelve loadings, the raw data counts were converted to forces and moments. Then for each interaction matrix, the same least squares equations were used to determine the interaction coefficients. These prime gage constants and interaction



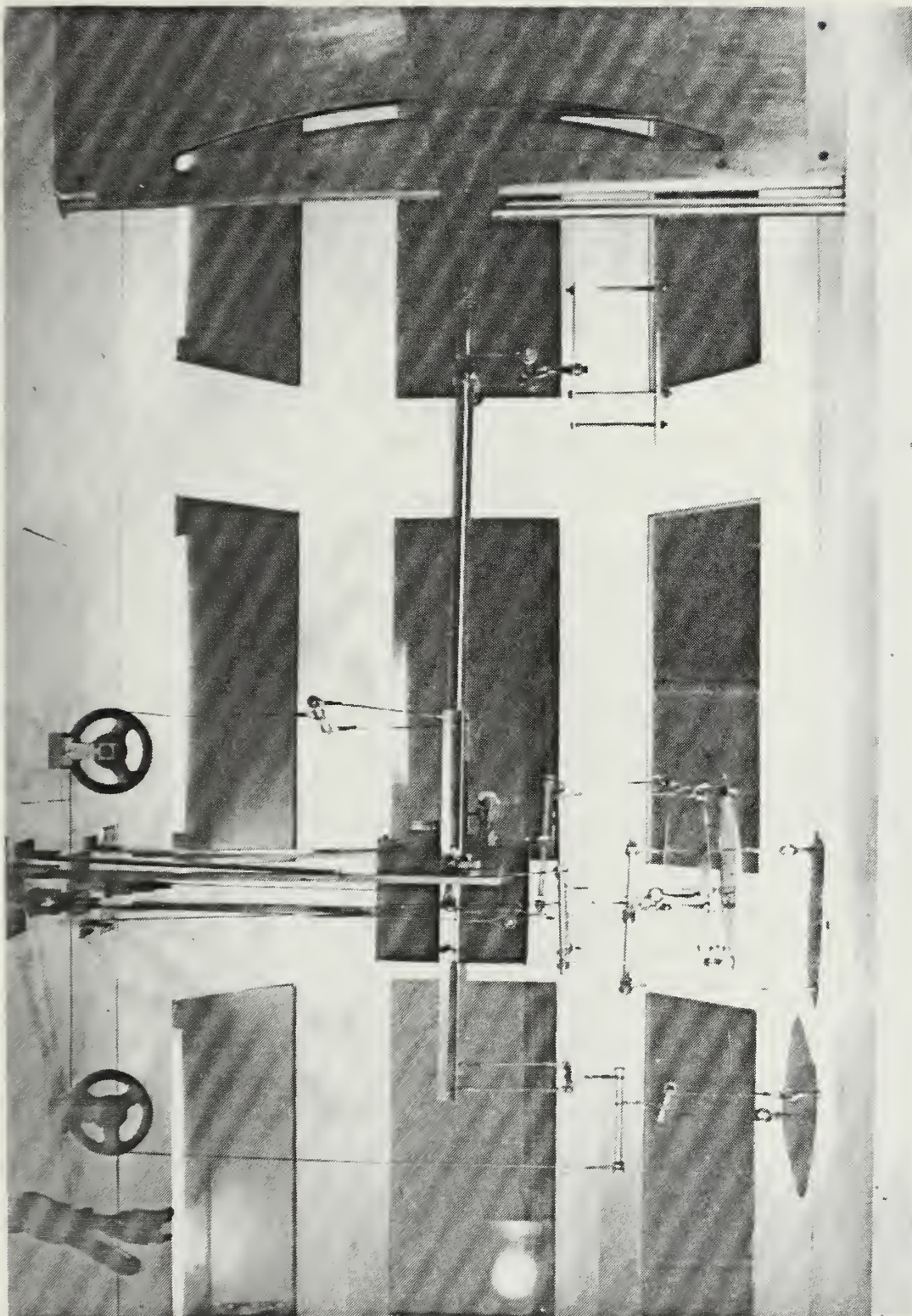


Figure 2.9 Balance Calibration Rig

coefficients were stored for use in the reduction of the raw data recorded during the wind tunnel tests.

#### D. DATA ACQUISITION

To improve data reduction, it was desired to have a data acquisition system built into the wind tunnel instrumentation. The strain gages on the internal balance and support sting were connected to a Pacific Instruments model 8255 transducer amplifier (Figure 2.10). The outputs from this unit were then routed to data acquisition cards mounted in an IBM PC AT. A data acquisition program, Figure A.10, was incorporated into the interactive program set that allowed for quick and easy recording of test data.

Having the transducer amplifier connected to the strain gages allowed for easy zeroing and balancing of the gages. The data acquisition set-up provided real time readout of the forces that the helicopter was experiencing in the wind tunnel.





Figure 2.10 Data Acquisition Equipment

### III. SOLUTION TO THE PROBLEM

#### A. DATA COLLECTION AND REDUCTION

The data collection program, Figure A.10, was designed to record the data in a standardized collection method. Interactive steps instruct the user to follow the procedures listed below.

- 1). Zero all amplifiers without the model in place.
- 2). Mount the model to the sting support and record a zero force reading.
- 3). Place the calibration switches to the + position and record a calibration reading.
- 4). Replace the calibration switchres to the center position and start the wind tunnel.
- 5). Record first and last data point at zero angle of attack with all other readings between plus ten degrees and minus eight degrees angle of attack.

By using a delay loop, changes could be made to the angle of attack of the model before the next set of data points were recorded. For each tunnel speed, the data recorded for the various angles of attack were stored on separate files.

Once the tunnel runs were completed and the data was recorded on file, another program, Figure A.11, was designed to convert the raw readings to readings of forces and monemts. The sixty interaction coefficients developed from the balance calibration were incorporated into this data reduction. The following equations, obtained from Mr.

David Backs at the NASA AMES Research Center, were used to correct for the interaction of the balance components.

$$F1' = F1 - (\text{del}F1/\text{del}F2)*F2 - (\text{del}F1/\text{del}F3)*F3 - \dots - (\text{del}F1/\text{del}F2^2)*F2^2 - \dots - (\text{del}F1/\text{del}F6^2)*F6^2$$

$$F1'' = F1 - (\text{del}F1/\text{del}F2)*F2' - \dots - (\text{del}F1/\text{del}F2^2)*F2'^2 - \dots - (\text{del}F1/\text{del}F6^2)*F6'^2$$

These equations were written for each component and placed in an iterative loop that checked the difference between the two prime values. After the forces were corrected for component interaction, a weight tare equation was used to correct for the weight of the model

## B. ANALYSIS OF DATA

The main file of the interactive programs, Figure A.9, controlled the data recording, data reduction and data analysis with a menu format. For data analysis, the stored converted data readings were used to calculate the lift and drag coefficients and equivalent flat plate area for each angle of attack. Files were created for coefficient of lift versus angle of attack, coefficient of drag versus coefficient of lift, coefficient of drag versus coefficient of lift squared and equivalent flat plate area versus angle of attack. There was one file of each created for each tunnel speed.

A plotting routine, Figure A.15, was included in the interactive programs to allow quick analysis of the recorded data. To aid in the analysis, up to three plots



could be shown on one graph. A delay loop was incorporated into the plotting routine to allow for the option of obtaining a hard copy of the graph by using the print screen command.

#### IV. RESULTS

##### A. BALANCE CALIBRATION

The balance was loaded in the twelve component directions and the balance calibration program was used to produce the tables B.2 through B.13. During the balance calibration, a drift in each of the components was noted under steady state conditions. To correct for this problem it was assumed that each component had a constant drift rate. The difference between the first and last zero reading was divided by the number of data points taken. This correction factor was then applied to each data point. This method produced good correlation between different data points taken for the same load.

##### B. DATA COLLECTION

Test runs were conducted to evaluate the data acquisition program. The vibrations of the model in the wind tunnel resulted in erratic fluctuations in the sense indicators of the amplifiers. To correct for this problem, the acquisition program was modified to collect one hundred samples at a rate of five hundred samples per second. The average of these one hundred samples was taken as one data point. This method produced constant readings for data points of similar conditions.



### C. DATA REDUCTION AND ANALYSIS

The data reduction program was used to convert the raw test data. The interaction equations diverged instead of converging to a single value. This pointed out a problem with the interaction coefficients. Examination of the calibration tables revealed extremely large interactions between the loading of the lift component and reaction in the roll moment component. There was also noted a large interaction between the loading of the pitch moment component and reaction in the lift component.

The reduction program was modified to correct for the interactions between the lift and drag components only. The reduction program was again executed using the recorded test data. This time the interactions converged. This proved the validity of the interaction equations and confirmed the problems with the balance calibration.

A test file was created to display the plotting capabilities of the interactive programs. Figure 4.1 shows the results.

# TEST FILES FOR PLOTTING

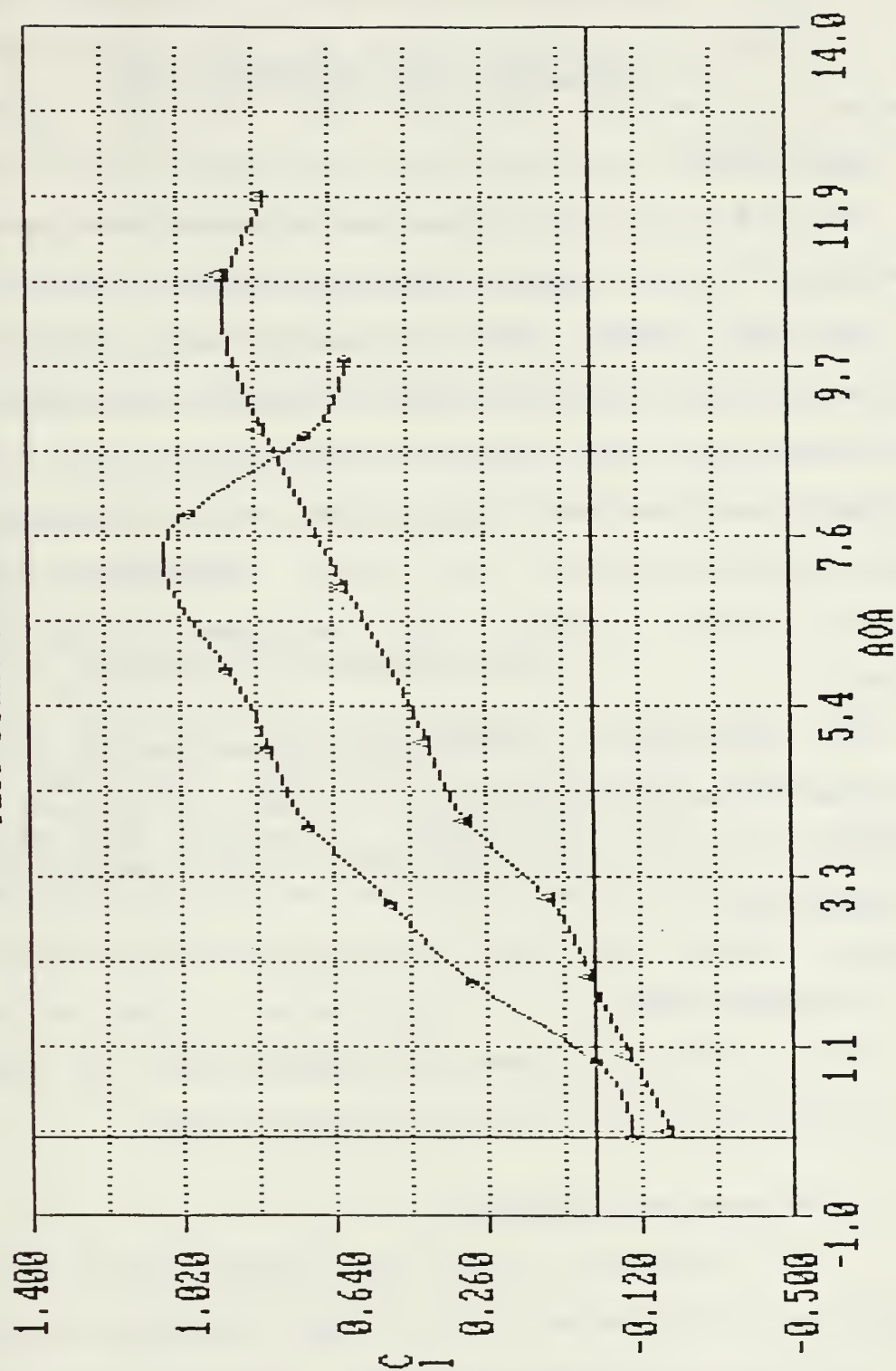


Figure 4.1 Output from Plotting Routine

## V. CONCLUSIONS AND RECOMMENDATIONS

### A. CONCLUSIONS

The data acquisition system and programs developed were adequate for recording the forces and moments experienced in the wind tunnel. The extremely large interactions between the lift and roll moment components and between the pitch moment and lift components (see Tables B.2 - B.13) precluded any analysis of wind tunnel data. However, the data acquisition system and balance calibration program warrant further research and development of the balance system.

The interactive programs greatly reduced the workload required in the data acquisition and analysis phases. They provided a quick and easy means for the analysis of the recorded data.

### B. RECOMMENDATIONS

The following are given as recommendations to improve the calibration of the internal balance system.

#### 1. Balance Modification

The location of the roll moment strain gage was decided to be the cause of the large interaction between the lift and roll moment component. This gage was located on the back end of the sting support system. The roll

moment component was calibrated by applying a torque to the center section of the model that was mounted to the internal balance. When the lift component was loaded, a large bending moment was felt by the roll moment gage and thus producing the large interactions.

By placing the roll moment strain gage at a forty-five degree angle on the same cut-out section as the pitch moment gage, the torque applied to the center section can be used for calibration. Also, the loading of the lift component will not greatly affect the reaction of the roll moment component.

## 2. Calibration Rig Modification

By using the center section of the model to mount the calibration pans for the pitch moment component, the strains were incorrectly transmitted to the lift component. A separate calibration set-up will have to be designed that isolates the force applied to the pitch moment component from the rest of the balance.

A hand-drawn technical sketch of a mechanical assembly. The main body is a large, irregular shape with a curved top and a vertical line on the right side. A horizontal line segment is labeled "4\"". A circular feature is shown on the right side, with a vertical dimension of "1 1/4\"". A small rectangular feature is attached to the side of the main body, with a horizontal dimension of "1 1/8\"". A curved line indicates a "95°" angle. A dimension of "3\" is shown for a curved feature. The drawing is on a light-colored background.

28





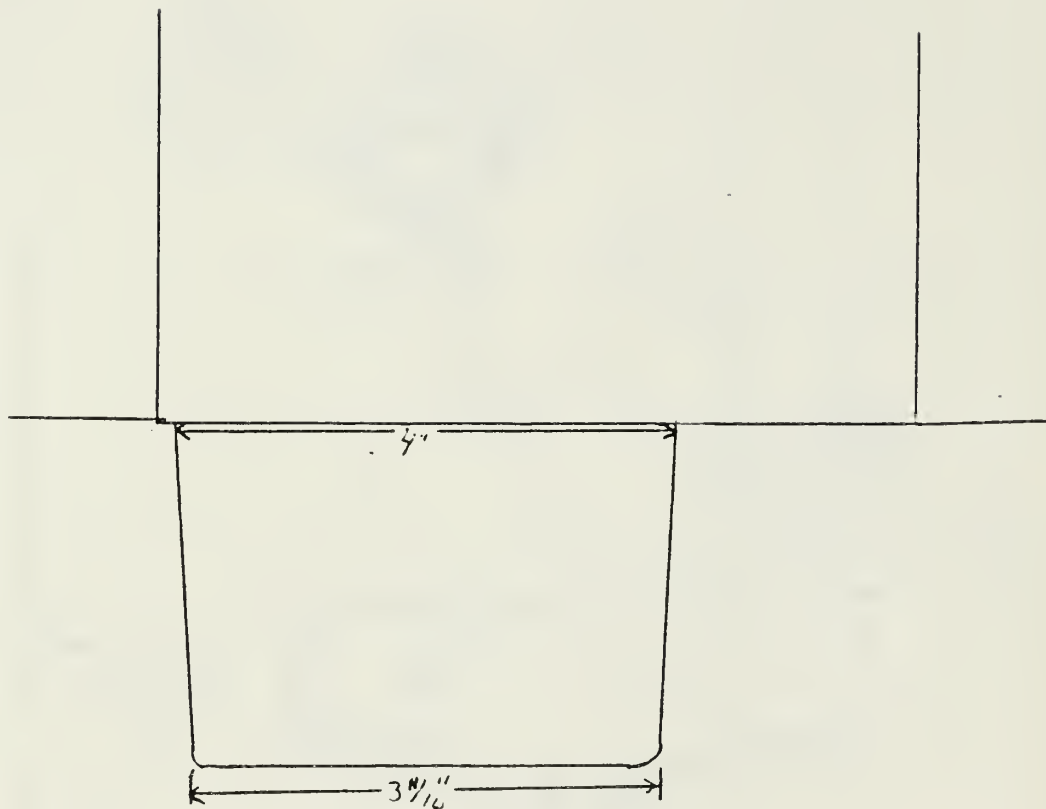


Figure A.3 Stubwing for Smooth Nose (Top View)

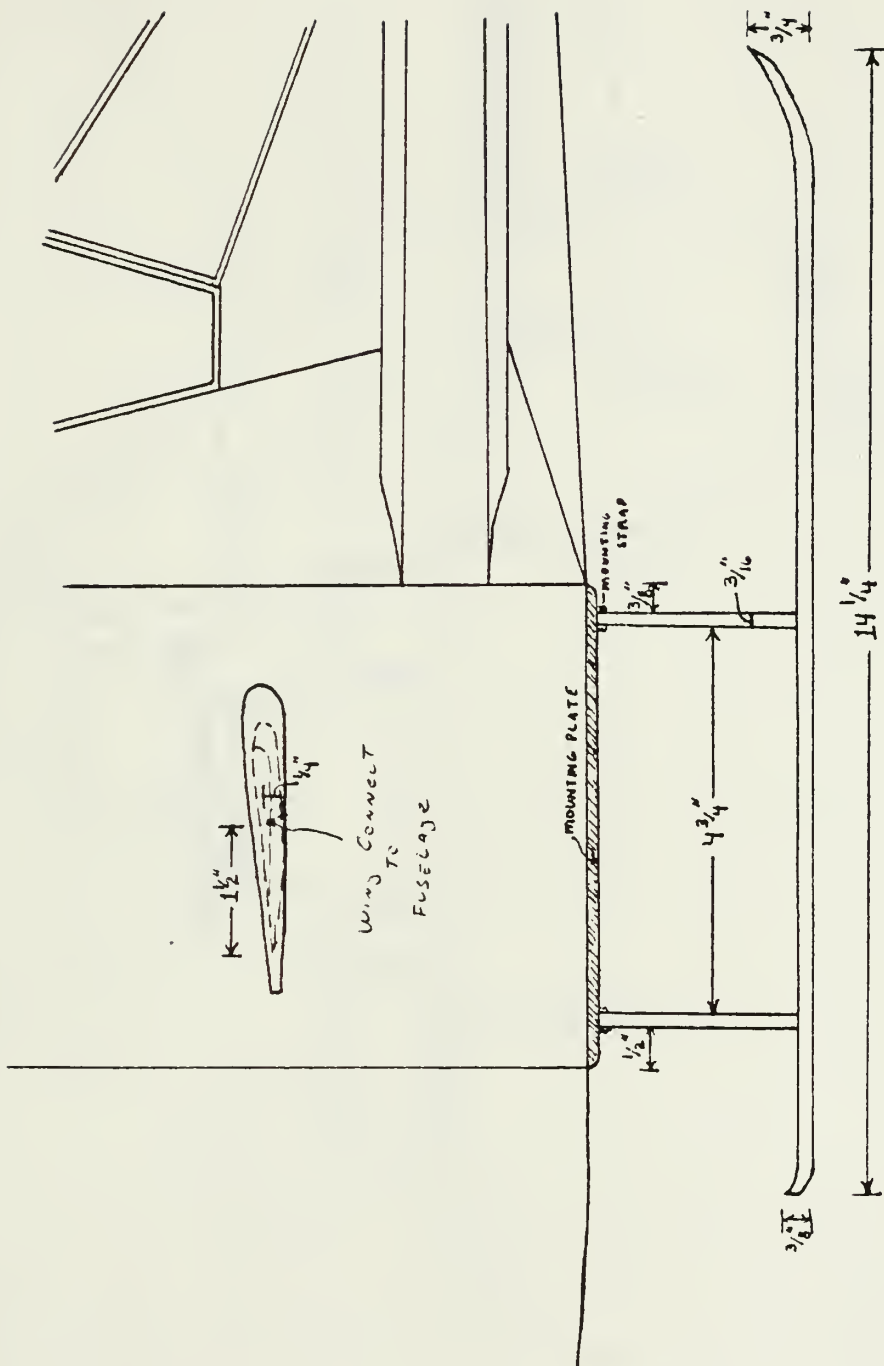


Figure A.4 Skid Gear and Wing for Attack Nose

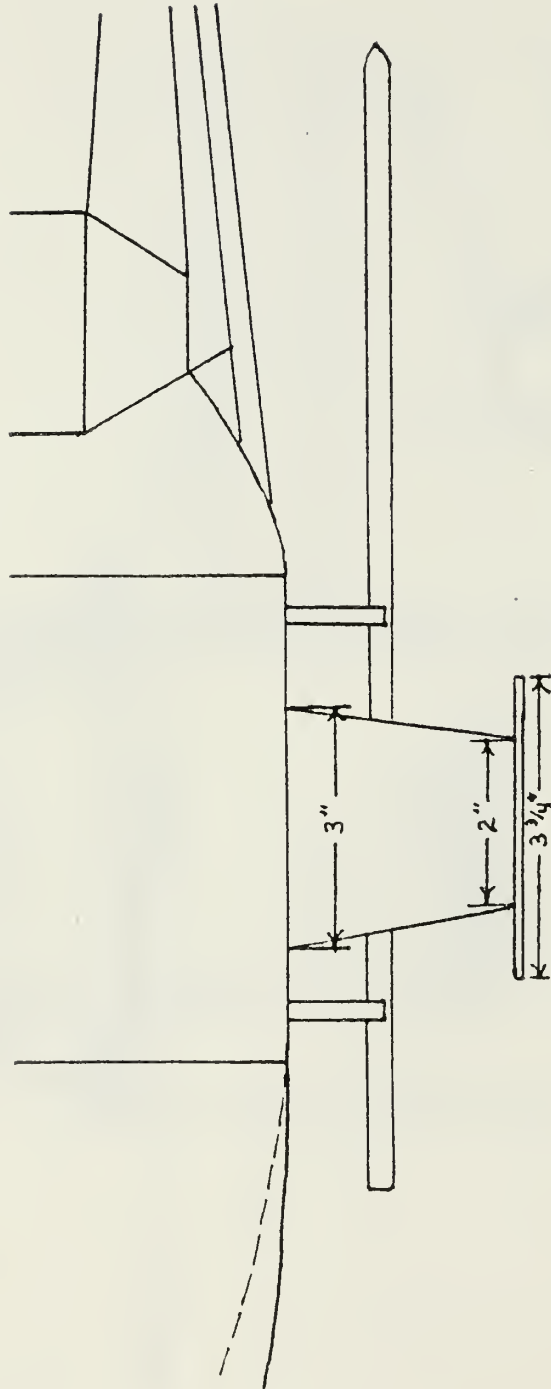


Figure A.5 Skid Gear for Attack Nose (Top View)

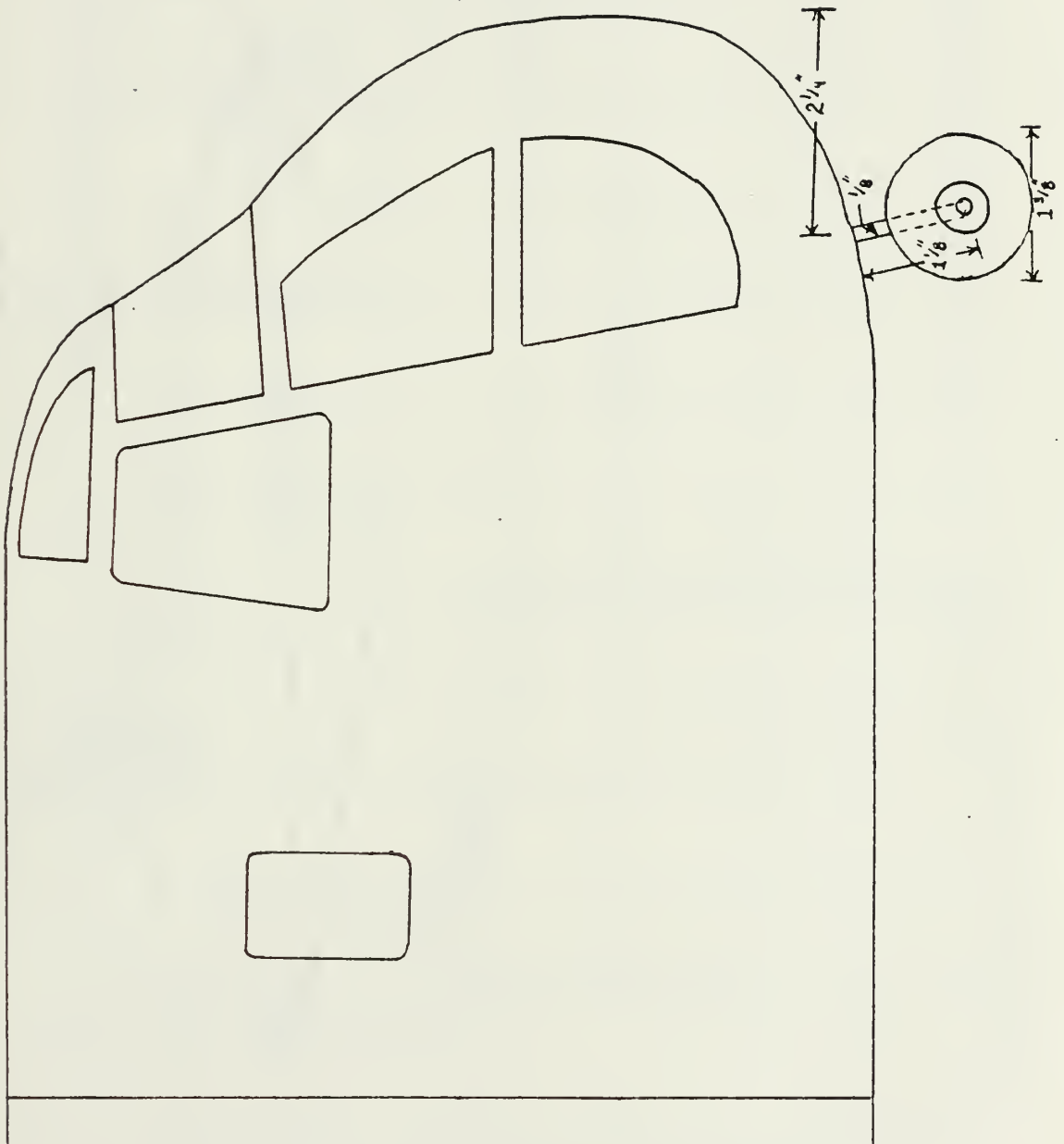


Figure A.6 Nose Gear for Blunt Nose



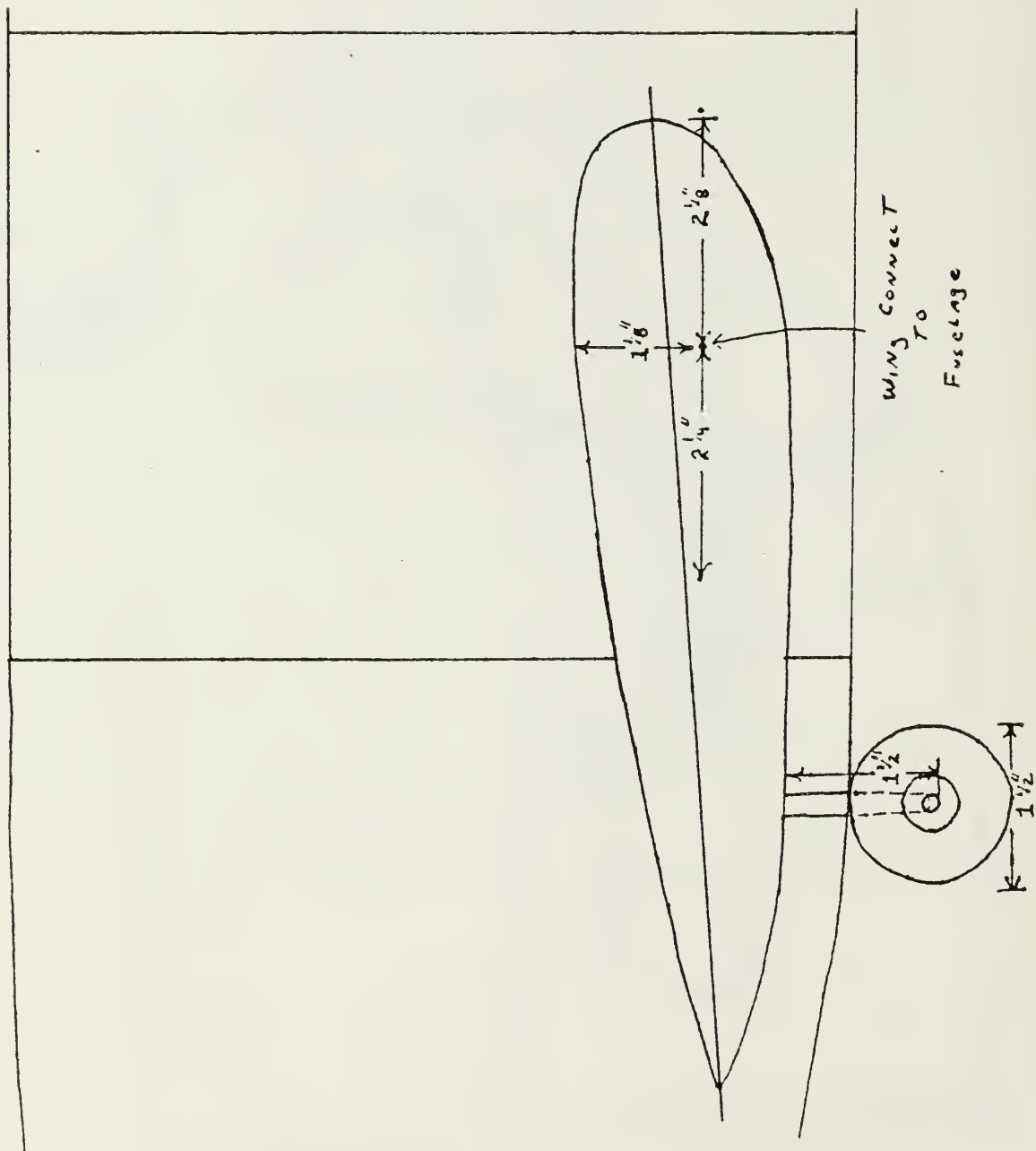


Figure A.7 Main Gear for Blunt Nose

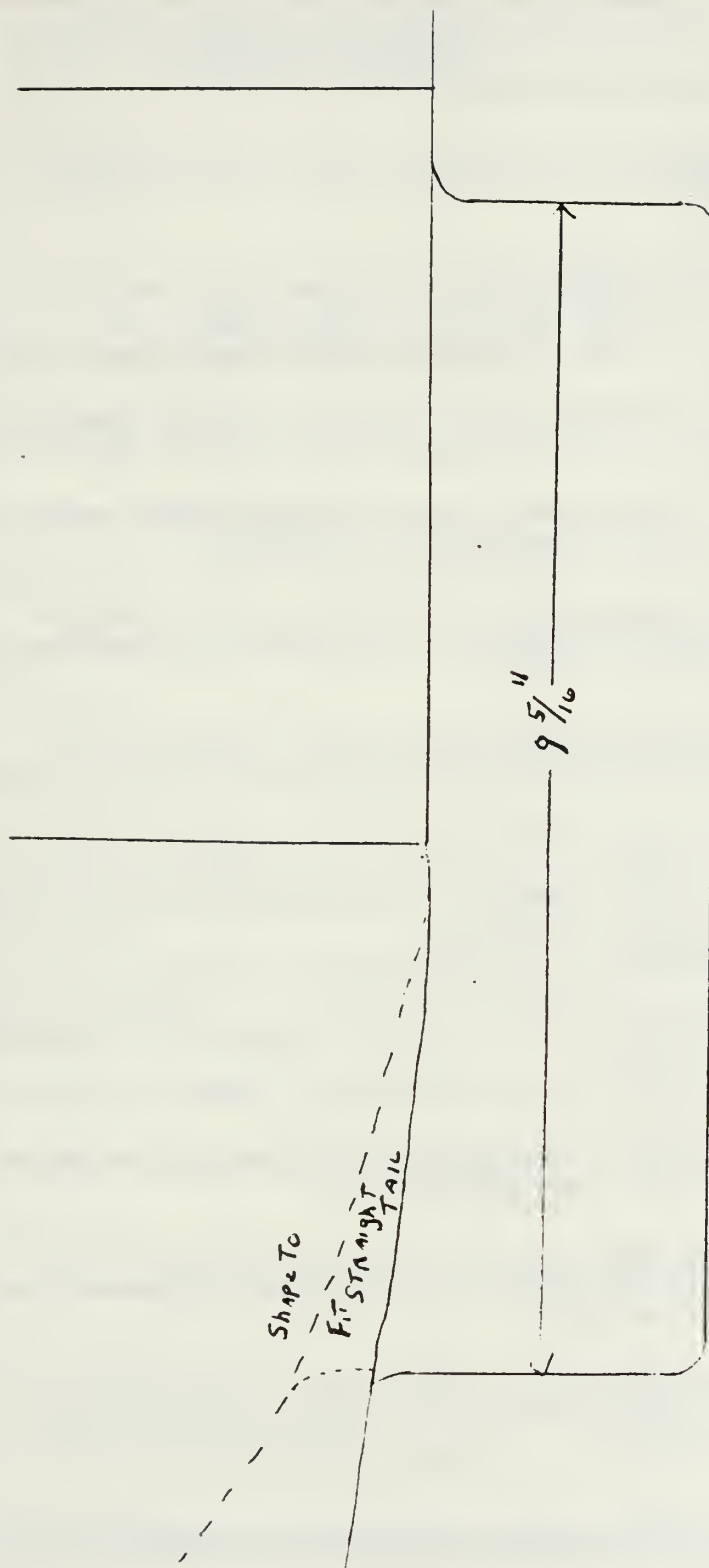


Figure A.8 Stubwing for Blunt Nose (Top View)

```

10  REM-----MAIN.BAS (MAIN CONTROL PROGRAM)-----
20  '                                     PATRICK A. WITT
30  '                                     20 JULY 1985
40  '-----
50  REM
280 KEY OFF
290 SCREEN 1
300 COLOR 1
310 FOR I = 1 TO 2
320 IF I = 1 THEN FILL = 11 ELSE FILL = 12
330 IF I = 1 THEN EDGE = 9 ELSE EDGE = 10
340 IF I = 1 THEN X1=106: X2=0: X3=56 ELSE X1=108: X2=2:
    X3=58
350 IF I = 1 THEN Y1=48: Y2=94: Y3=140 ELSE Y1=46: Y2=92:
    Y3=138
360 ' "H"
370 DRAW "C=EDGE;BM=X1;,,=Y1;U30R4D12R12U12R4D30L4U12"
380 DRAW "L12D12L4BE1P=FILL;,,=EDGE;"
390 ' "E"
400 X1= X1 + 26
410 DRAW "C=EDGE;BM=X1;,,=Y1;U30R20D4L16D9R8D4L8D9R16D4L2
    0BE1P=FILL;,,=EDGE;"
420 ' "L"
430 X1= X1 + 26
440 DRAW "C=EDGE;BM=X1;,,=Y1;U30R4D26R16D4L20BE1P=FILL;,,
    =EDGE;"
450 ' "O"
460 X1= X1 + 26
470 DRAW "C=EDGE;BM=X1;,,=Y1;U30R20D30L20BR4BU4U22R12D22L
    12BG1P=FILL;,,=EDGE;"
480 'NEXT LINE
490 ' "C"
500 DRAW "C=EDGE;BM=X2;,,=Y2;U30R20D4L16D22R16D4L20BE1P=
    FILL;,,=EDGE;"
510 ' "O"
520 X2= X2 + 26
530 DRAW "C=EDGE;BM=X2;,,=Y2;U30R20D30L20BR4BU4U22R12D22L
    12BG1P=FILL;,,=EDGE;"
540 ' "N"
550 X2= X2 + 26
560 DRAW "C=EDGE;BM=X2;,,=Y2;U30R4F12U12R4D30L4H12D12L4BE
    1P=FILL;,,=EDGE;"
570 ' "F"
580 X2= X2 + 26
590 DRAW "C=EDGE;BM=X2;,,=Y2;U30R20D4L16D6R8D4L8D16L4BE1P=
    FILL;,,=EDGE;"
600 ' "I"
610 X2= X2 + 26
620 DRAW "C=EDGE;BM=X2;,,=Y2;U30R4D30L4BE1P=FILL;,,=EDGE;"
630 ' "G"

```

Figure A. 9 MAIN.BAS - Main Controlling Program

```

640 X2= X2 + 14
650 DRAW "C=EDGE;BM=X2; ,=Y2;U30R20D4L16D22R12U4L4U4R8"
660 DRAW "D12L20BE1P=FILL; ,=EDGE;"
670 ' "U"
680 X2= X2 + 26
690 DRAW "C=EDGE;BM=X2; ,=Y2;U30R4D26R12U26R4D30L20BE1P=
FILL; ,=EDGE;"
700 ' "R"
710 X2= X2 + 26
720 DRAW "C=EDGE;BM=X2; ,=Y2;U30R20D15L12F15L4H15D15L4BU1
9BR4U7"
730 DRAW "R12D7L12BL1P=FILL; ,=EDGE;"
740 ' "A"
750 X2= X2 + 30
760 DRAW "C=EDGE;BM=X2; ,=Y2;U30R20D30L4U15L12D15L4BU19BR
4U7"
770 DRAW "R12D7L12BL1P=FILL; ,=EDGE;"
780 ' "T"
790 X2= X2 + 26
800 DRAW "C=EDGE;BM=X2; ,=Y2;BU26U4R20D4L8D26L4U26L8BE1P=
FILL; ,=EDGE;"
810 ' "I"
820 X2= X2 + 26
830 DRAW "C=EDGE;BM=X2; ,=Y2;U30R4D30L4BE1P=FILL; ,=EDGE;"
840 ' "O"
850 X2= X2 + 14
860 DRAW "C=EDGE;BM=X2; ,=Y2;U30R20D30L20BR4BU4U22R12D22L
12BG1P=FILL; ,=EDGE;"
870 ' "N"
880 X2= X2 + 26
890 DRAW "C=EDGE;BM=X2; ,=Y2;U30R4F12U12R4D30L4H12D12L4BE
1P=FILL; ,=EDGE;"
900 'NEW LINE
910 ' "A"
920 DRAW "C=EDGE;BM=X3; ,=Y3;U30R20D30L4U15L12D15L4BU19BR
4U7"
930 DRAW "R12D7L12BL1P=FILL; ,=EDGE;"
940 ' "N"
950 X3= X3 + 26
960 DRAW "C=EDGE;BM=X3; ,=Y3;U30R4F12U12R4D30L4H12D12L4BE
1P=FILL; ,=EDGE;"
970 ' "A"
980 X3= X3 + 26
990 DRAW "C=EDGE;BM=X3; ,=Y3;U30R20D30L4U15L12D15L4BU19BR
4U7"
1000 DRAW "R12D7L12BL1P=FILL; ,=EDGE;"
1010 ' "L"
1020 X3= X3 + 26
1030 DRAW "C=EDGE;BM=X3; ,=Y3;U30R4D26R16D4L20BE1P=FILL; ,=
EDGE;"

```

Figure A.9 MAIN.BAS (cont.)



```

1040 ' "Y"
1050 X3= X3 + 26
1060 DRAW "C=EDGE;BM=X3;,,=Y3;BU30BL1R5F9R4E9R5G14D16L4"
1070 DRAW "U16H14BR2BD1P=FILL;,,=EDGE;"
1080 ' "S"
1090 X3= X3 + 40
1100 DRAW "C=EDGE;BM=X3;,,=Y3;BU1U2E2R16H19U4E2R20F2D2G2"
1110 DRAW "L16F19D4G2L20H2BR2BU1P=FILL;,,=EDGE;"
1120 ' "I"
1130 X3= X3 + 32
1140 DRAW "C=EDGE;BM=X3;,,=Y3;U30R4D30L4BE1P=FILL;,,=EDGE;"
1150 ' "S"
1160 X3= X3 + 14
1170 DRAW "C=EDGE;BM=X3;,,=Y3;BU1U2E2R16H19U4E2R20F2D2G2"
1180 DRAW "L16F19D4G2L20H2BR2BU1P=FILL;,,=EDGE;"
1190 NEXT I
1200 LOCATE 22,4
1210 INPUT "WOULD YOU LIKE INSTRUCTIONS (Y/N)";Z$
1220 IF Z$ = "Y" OR Z$ = "y" THEN GOTO 1240
1230 GOTO 2000
1240 SCREEN 0
1250 WIDTH 80
1260 COLOR 15,1
1270 CLS
1280 PRINT
1290 PRINT TAB(15)"THIS IS A MENU DRIVEN PROGRAM THAT
WILL ALLOW YOU TO"
1300 PRINT TAB(10)"EVALUATE DIFFERENT HELICOPTER CONFIGU
RATIONS AND DETERMINE"
1310 PRINT TAB(10)"THEIR LIFT AND DRAG COEFFICIENTS AND
THEIR EQUIVALENT FLAT"
1320 PRINT TAB(10)"PLATE AREA. THE DATA GENERATED DURING
THE TUNNEL RUNS WILL"
1330 PRINT TAB(10)"BE USED WITH THIS PROGRAM."
1340 PRINT TAB(15)"THE FIRST OPTION IS USED TO RECORD
THE DATA DURING"
1350 PRINT TAB(10)"THE TUNNEL RUNS. THE SECOND OPTION
CONVERTS THE RECORDED"
1360 PRINT TAB(10)"RAW COUNTS TO FORCES AND MOMENTS. YOU
WILL HAVE THE CHANCE"
1370 PRINT TAB(10)"TO PROVIDE NAMES FOR EACH OF THESE
FILES AS YOU GO ALONG."
1380 PRINT TAB(10)"THE THIRD OPTION LETS YOU EXAMINE THE
FORCES RECORDED. IT"
1390 PRINT TAB(10)"WILL BE OF NO USE TO YOU TO EXAMINE THE
RAW COUNTS."
1400 PRINT TAB(15)"THE FOURTH OPTION USES THE CONVERTED
DATA TO COMPUTE"
1410 PRINT TAB(10)"THE DESIRED PARAMETERS. THE DATA
MUST BE CONVERTED USING"

```

Figure A.9 MAIN.BAS (cont.)

```

1420 PRINT TAB(10)"OPTION TWO BEFORE THE PARAMETERS CAN BE
    CALCULATED. YOU WILL"
1430 PRINT TAB(10)"THEN PROVIDE A NAME FOR THE FILES THAT
    STORE THE CALCULATED"
1440 PRINT TAB(10)"PARAMETERS. USING THESE FILE NAMES,
    THE FIFTH OPTION LETS"
1450 PRINT TAB(10)"YOU EXAMINE THE DATA THAT CAN BE
    PLOTTED."
1455 PRINT:INPUT "PRESS RETURN TO CONTINUE";N
1456 CLS
1460 PRINT TAB(15)"OPTION SIX MUST BE USED TO SORT THE
    X VALUES BEFORE"
1470 PRINT TAB(10)"THEY CAN BE PLOTTED. THE SEVENTH OPTION
    LETS YOU ADD A GRID"
1480 PRINT TAB(10)"TO THE PLOT AND ALSO MARK THE DATA
    POINTS. THE PLOTTING IS"
1490 PRINT TAB(10)"IS EXECUTED WITH THE EIGHTH OPTION.
    YOU CAN PLOT UP TO"
1500 PRINT TAB(10)"THREE CURVES PER PLOT AND RECEIVE A
    HARD COPY BY PRESSING"
1510 PRINT TAB(10)"THE CTRL-PRTRSC BUTTONS. THE FINAL
    OPTION TERMINATES THIS"
1520 PRINT TAB(10)"PROGRAM."
1530 PRINT: INPUT "PRESS RETURN TO CONTINUE";N
2000 '-----PLOTTER SET-UP-----
2010 SCREEN 0: WIDTH 80: COLOR 14,0,7: CLS: LOCATE 10,1
2020 PRINT "WHICH DISK DRIVE DO YOU WANT TO STORE YOUR
    DATA FILES ON";
2030 PRINT
2040 PRINT "DRIVE A IS EITHER ON YOUR LEFT OR ON TOP"
2050 PRINT "DRIVE B IS EITHER ON YOUR RIGHT OR ON THE
    BOTTOM"
2070 PRINT
2080 INPUT "ENTER [ A OR B ]";FD$: FD$=FD$+" ": PD$="C:"
2090 GRD$="NO GRID": MRK$="MARK "
2100 OPT$="CURVE"
2110 GOSUB 2230
2120 GOSUB 2400
2130 X%=5+DX%: Y%=12: LOCATE X%,Y%,1,0,7
2140 FIRST%=5: LAST%=13
2150 ANS$=INKEY$: IF ANS$="" THEN 2150
2160 IF ANS$=CHR$(0)+CHR$(80) THEN IF X%<LAST% THEN X%=
    X%+1 ELSE X%=FIRST%
2170 IF ANS$=CHR$(0)+CHR$(72) THEN IF X%>FIRST% THEN X%=
    X%-1 ELSE X%=LAST%
2180 LOCATE X%,Y%: IF ANS$<>CHR$(13) THEN 2150
2190 FLAG1%=CSRLIN: FLAG1%=FLAG1%-4
2200 ON FLAG1% GOSUB 3120,2740,2630,2800,2680,3170,2870,
    3550,3680
2210 IF FLAG1%<>1 THEN GOTO 2120 ELSE GOTO 2130

```

Figure A.9 MAIN.BAS (cont.)

```

2220 '-----INITIALIZING CONSTANTS-----
2230 DIM X(300),B(300),C(300),D(300),Y(300)
2240 DIM FILESTK$(10)
2250 OUT 985,6
2260 SX%=5: SY%=55
2270 M$="COMMAND : "
2280 BLANK$=" "
2290 B$=" "
2300 SCREEN 0,1: CLS
2310 HDPOS%=48
2320 KEY(1) ON: ON KEY (1) GOSUB 2350
2330 RETURN
2340 '-----CHANGE FOREGROUND COLORS-----
2350 FG%=FG%+1
2360 IF FG%>15 THEN FG%=1
2370 OUT 985,FG%
2380 RETURN
2390 '-----PRINT MAIN OPTION MENU-----
2400 SCREEN 0,1: COLOR 14,0,7: CLS: LOCATE 3,1
2410 PRINT TAB(5) "*****" MAIN OPTIONS MENU
2420 PRINT
2430 PRINT TAB(5) "*" _ RECORD TUNNEL DATA
2440 PRINT TAB(5) "*" _ REDUCE RAW TUNNEL DATA
2450 PRINT TAB(5) "*" _ EXAMINE DATA FILE FOR TUNNEL
2460 PRINT TAB(5) "*" _ CALCULATE Cd, Cl, AND E.F.P.A.
2470 PRINT TAB(5) "*" _ EXAMINE DATA FILE FOR PLOTTI
2480 PRINT TAB(5) "*" _ SORT X VALUES
2490 PRINT TAB(5) "*" _ PLOTTING OPTION MENU
2500 PRINT TAB(5) "*" _ DO PLOTTING
2510 PRINT TAB(5) "*" _ EXIT
2520 PRINT
2530 PRINT TAB(5) "*****"
2540 LOCATE 3,65,1: PRINT "STATUS"
2550 LOCATE 4,55 : PRINT "-----"
2560 LOCATE SX%,SY% : PRINT "DATA FILE DRIVE = "+FD$
2570 LOCATE SX%+2,SY% : PRINT "USER OPTIONS : "
2580 LOCATE SX%+3,SY% : PRINT OPT$
2590 LOCATE SX%+4,SY% : PRINT GRD$
2600 LOCATE SX%+5,SY% : PRINT MRK$

```

Figure A.9 MAIN.BAS (cont.)

```

2610 RETURN
2620 '---DATA EDITOR FOR TUNNEL DATA-----
2630 CHAINFILE$ = PD$+"ADATA.BAS"
2640 DX%=2
2650 COMMON FD$,PD$,DX%
2660 CHAIN CHAINFILE$
2670 RETURN
2680 '---DATA EDITOR FOR PLOTTING DATA-----
2690 CHAINFILE$ = PD$+"BDATA.BAS"
2700 DX%=5
2710 COMMON FD$,PD$,DX%
2720 CHAIN CHAINFILE$
2730 RETURN
2740 '----DATA REDUCTION-----
2750 CHAINFILE$ = PD$+"RED.BAS"
2760 DX%=3
2770 COMMON PD$,FD$,DX%
2780 CHAIN CHAINFILE$
2790 RETURN
2800 '-----CALCULATE ROUTINE-----
2810 CHAINFILE$ = PD$ + "COMP.BAS"
2820 DX%=4
2830 COMMON PD$,FD$,DX%
2840 CHAIN CHAINFILE$
2850 REUTRN
2860 '----PLOTTING OPTION MENU-----
2870 CLS: SCREEN 0,1: LOCATE 6,1
2880 PRINT TAB(20) "***** PLOTTING OPTION MENU      ***
    ***"
2890 PRINT
2900 PRINT TAB(20) "*"          _      GRID &      MARK
    "*"
2910 PRINT TAB(20) "*"          _      GRID & NO MARK
    "*"
2920 PRINT TAB(20) "*"          _      NO GRID &      MARK
    "*"
2930 PRINT TAB(20) "*"          _      NO GRID & NO MARK
    "*"
2940 PRINT TAB(20) "*"          _      EXIT
    "*"
2950 PRINT
2960 PRINT TAB(20) "*****
    ***"
2970 X%=8: Y%=27: LOCATE X%,Y%,1,0,7
2980 FIRST%=8: LAST%=12
2990 ANS$=INKEY$: IF ANS$="" THEN 2990
3000 IF ANS$=CHR$(0)+CHR$(80) THEN IF X%<LAST% THEN X%=
    X%+1 ELSE X%=FIRST%
3010 IF ANS$=CHR$(0)+CHR$(72) THEN IF X%>FIRST% THEN X%=
    X%+1 ELSE X%=LAST%

```

Figure A.9 MAIN.BAS (cont.)



```

3020 LOCATE X%,Y%: IF ANS$<>CHR$(13) THEN 2990
3030 FLAG%=CSRLIN: FLAG%=FLAG%-7
3040 ON FLAG% GOSUB 3070,3080,3090,3100,3110
3050 DX%=7
3060 RETURN
3070 GRD$="GRID   ": MRK$="MARK   " : RETURN
3080 GRD$="GRID   ": MRK$="NO MARK" : RETURN
3090 GRD$="NO GRID": MRK$="MARK   " : RETURN
3100 GRD$="NO GRID": MRK$="NO MARK" : RETURN
3110 RETURN
3120 '-----RECORD TUNNEL DATA-----
3130 CHAINFILE$ = PD$ + "RUNS.BAS"
3140 DX%=1
3145 COMMON PD$,FD$,DX%
3150 CHAIN CHAINFILE$
3155 RETURN
3160 '-----SORTING-----
3170 CLS: INPUT "ENTER NAME OF FILE TO BE SORTED";FILE$:
      FILE$=FD$+FILE$
3180 PRINT "READING FILE "+FILE$+"...": BEEP
3190 GOSUB 3370
3200 PRINT "SORTING"
3210 L%=2: K%=NOD%-1: R%=NOD%
3220 WHILE (L%<=R%)
3230     FOR J%=R% TO L% STEP -1
3240         IF (X(J%-1)>X(J%)) THEN SWAP X(J%),X(J%-1): SWAP
            Y(J%),Y(J%-1): K%=J%
3250     NEXT
3260     L%=K%-1
3270     FOR J% = L% TO R%
3280         IF (X(J%-1)>X(J%)) THEN SWAP X(J%),X(J%-1): SWAP
            Y(J%),Y(J%-1): K%=J%
3290     NEXT
3300     R%=K%+1
3310 WEND
3320 CLS:BEEP
3330 PRINT "SORTED FILE ";FILE$;" BEING SAVED ...": GOSUB
      3460
3340 DX%=6
3350 RETURN
3360 '-----READING A FILE-----
3370 OPEN FILE$ FOR INPUT AS #2
3380 INPUT #2,NOD%,Y1$,X1$,CONFIG$,CONF
3390 INPUT #2,Q
3400     FOR J = 1 TO NOD%
3410         INPUT #2,Y(J),X(J)
3420     NEXT
3430 CLOSE #2
3440 RETURN
3450 '-----SAVE A FILE-----

```

Figure A.9 MAIN.BAS (cont.)



```

3460 OPEN FILE$ FOR OUTPUT AS #1
3470 WRITE #1,NOD%,Y1$,X1$,CONFIG$,CONF
3480 WRITE #1,Q
3490   FOR J = 1 TO NOD%
3500       WRITE #1,Y(J),X(J)
3510   NEXT
3520 CLOSE #1
3530 RETURN
3540 '-----INITIALIZING PLOTTER-----
3550 CLS: INPUT "NUMBER OF DATA FILE(S) TO BE PLOTTED ON
THE SAME PLOT =";NOF%
3560 PRINT "ENTER FILE NAME (S) :":BEEP
3570 FOR I% = 1 TO NOF%
3580     PRINT "FILE #";:PRINT USING "##";I%; : INPUT " =";
FILE$
3590     FILE$ = FD$ + FILE$
3600     FILESTK$(I%) = FILE$
3601     PRINT "HOW DO YOU WANT THIS CURVE PLOTTED ?  ENTER
(PPOINT) TO JUST PLOT"
3602     INPUT "THE POINTS OR (CURVE) TO PRODUCE A CURVE
FIT";OPT$
3610     CURVE$(I%) = OPT$
3620 NEXT
3630 PFILE$ = PD$+"MAIN.BAS": FILE2$= PD$ + "PLOTTER.BAS"
3640 SL% = 100
3650 CHAIN FILE2$,30,ALL
3660 DX%=8
3670 RETURN
3680 CLS:
3690 LOCATE 10,5: PRINT "PROGRAM TERMINATED, REMOVE DATA
FILES FROM DISK DRIVE"
3700 LOCATE 11,5: PRINT "AND SECURE COPMUTER AND AMPLIFIE
S"
3710 END

```

Figure A.9 MAIN.BAS (cont.)

```

10 'NAME:   Data Acquisition And Control (DAAC)
20 '       HEADER for BASICA
30 '
40 'FILE NAME:   DACHDR.BAS
50 '
60 'DOS DEVICE NAME:   DAAC
70 '
80 'RESERVED FUNCTION NAMES:
90 '       AINM, AINS, AINSC, AOUM, AOUS,
100 '       BINM, BINS, BITINS, BITOUS, BOUM, BOUS,
110 '       CINM, CINS, CSET, DELAY
120 'RESERVED DEF SEG VALUE NAME:   DSEG
130 '
140 'NAMES DEFINED AND USED BY HEADER:
150 '       ADAPT%, AI, COUNT, FOUND%,
160 '       HNAME$, SG%, STAT%
170 '
180 '
190 'When using the BASICA Interpreter, this header
200 'must be executed before any function calls are
210 'made that access the DAAC adapter. It initializes
220 'a number of variables for each function call. These
230 'variables are reserved and should not be used except
240 'to access the DAAC adapter. This routine also does a
250 'DEF SEG to the segment where the DAAC Device Driver
260 '(DAC.COM) is loaded. If you execute a DEF SEG to
270 'access other hardware, you must DEF SEG to the segment
280 'of the DAAC Device Driver before any subsequent
290 'calls to access the DAAC adapter.
300 '
310 '
320 FOUND% = 0
330 SG% = &H2E
340 'Start searching the interrupt vectors until you find
350 'one that points to the DAAC device driver.
360 'Do a DEF SEG to that segment.
370 WHILE ((SG% <= &H3E) AND (FOUND% = 0))
380     DEF SEG = 0
390     DSEG = PEEK(SG%) + PEEK(SG% + 1) * 256
400     DEF SEG = DSEG
410     HNAME$=""
420     FOR AI=10 TO 17
430         HNAME$ = HNAME$ + CHR$(PEEK(AI))
440     NEXT AI
450     IF HNAME$ = "DAAC" AND PEEK(18) + PEEK(19) <>
460         0 THEN FOUND% = 1
460     SG% = SG% + 4
470 WEND
480 IF FOUND% = 0 THEN PRINT "ERROR: DEVICE DRIVER DAC.COM
    NOT FOUND" : END

```

Figure A.10 RUNS.BAS - Data Acquisition Program

```

490 'Now initialize all function name variables for calls
500 'to access the device driver.
510 AINM      = PEEK(&H13) * 256 + PEEK(&H12)
520 AINS      = PEEK(&H15) * 256 + PEEK(&H14)
530 AINSC     = PEEK(&H17) * 256 + PEEK(&H16)
540 AOUM      = PEEK(&H19) * 256 + PEEK(&H18)
550 AOUS      = PEEK(&H1B) * 256 + PEEK(&H1A)
560 BINM      = PEEK(&H1D) * 256 + PEEK(&H1C)
570 BINS      = PEEK(&H1F) * 256 + PEEK(&H1E)
580 BITINS    = PEEK(&H21) * 256 + PEEK(&H20)
590 BITOUS    = PEEK(&H23) * 256 + PEEK(&H22)
600 BOUM      = PEEK(&H25) * 256 + PEEK(&H24)
610 BOUS      = PEEK(&H27) * 256 + PEEK(&H26)
620 CINM      = PEEK(&H29) * 256 + PEEK(&H28)
630 CINS      = PEEK(&H2B) * 256 + PEEK(&H2A)
640 CSET      = PEEK(&H2D) * 256 + PEEK(&H2C)
650 DELAY     = PEEK(&H2F) * 256 + PEEK(&H2E)
660 'Finally, execute any call to re-initialize the
670 'device driver from any former invocation of BASIC.
680 ADAPT% = 0
690 COUNT = 1
700 STAT% = 0
710 CALL DELAY (ADAPT%, COUNT, STAT%)
720 '
730 'End of DAAC BASICA Header
740 '
750 REM-- RUNS.BAS; PROGRAM TO RECORD THE DATA FROM
WIND
760 REM-- TUNNEL RUNS
770 KEY OFF: COLOR 15,1,4: CLS
780 CLS
790 PRINT: PRINT
800 PRINT TAB(10) "HELO CONFIGURATIONS"
810 PRINT: PRINT
820 PRINT TAB(5) "1. ATTACK NOSE, STRAIGHT TAIL"
830 PRINT TAB(5) "2. ATTACK NOSE, LOW TAIL"
840 PRINT TAB(5) "3. ATTACK NOSE, HIGH TAIL"
850 PRINT TAB(5) "4. SMOOTH NOSE, STRAIGHT TAIL"
860 PRINT TAB(5) "5. SMOOTH NOSE, LOW TAIL"
870 PRINT TAB(5) "6. SMOOTH NOSE, HIGH TAIL"
880 PRINT TAB(5) "7. BLUNT NOSE, STRAIGHT TAIL"
890 PRINT TAB(5) "8. BLUNT NOSE, LOW TAIL"
900 PRINT TAB(5) "9. BLUNT NOSE, HIGH TAIL"
910 PRINT: PRINT
920 INPUT "WHICH CONFIGURATION IS BEING RUN";N
930 PRINT
940 INPUT "DOES CONFIGURATION INCLUDE LANDING GEAR";Z$
950 ON N GOSUB 4550,4620,4690,4750,4820,4870,4920,4990,
5040
955 '----- WEIGHTS ARE IN POUNDS-----

```

Figure A.10 RUNS.BAS (cont.)

```

960 IF CONF = 10 THEN W = 22.7892
970 IF CONF = 15 THEN W = 23.4623
980 IF CONF = 20 THEN W = 24.6945
990 IF CONF = 25 THEN W = 25.3676
1000 IF CONF = 30 THEN W = 24.6945
1010 IF CONF = 35 THEN W = 25.3676
1020 IF CONF = 40 THEN W = 20.8134
1030 IF CONF = 45 THEN W = 21.5866
1040 IF CONF = 50 THEN W = 22.7187
1050 IF CONF = 55 THEN W = 23.4913
1060 IF CONF = 60 THEN W = 22.7187
1070 IF CONF = 65 THEN W = 23.4913
1080 IF CONF = 70 THEN W = 21.3315
1090 IF CONF = 75 THEN W = 23.2892
1100 IF CONF = 80 THEN W = 23.2368
1110 IF CONF = 85 THEN W = 25.1945
1120 IF CONF = 90 THEN W = 23.2368
1130 IF CONF = 95 THEN W = 25.1945
1140 CLS
1150 REM-----RECORD TUNNEL DATA-----
1160 DIM L(100),D(100),Y(100),PM(100),YM(100),RM(100),AOA(
100)
1170 DIM DAT(399),DAT%(399),DAT1(399),DAT1%(399)
1180 COLOR 15,1: KEY OFF: CLS
1190 PRINT "RECORDING OF WIND TUNNEL RAW DATA"
1200 INPUT "WHAT IS THE TUNNEL SPEED (Q) FOR THIS RUN";Q
1210 PRINT
2670 PRINT "WITHOUT THE MODEL IN PLACE, ADJUST THE ZERO
SET SCREWS TO ZERO"
2671 PRINT "OUT EACH AMPLIFIER. AFTER ALL AMPLIFIERS ARE
ZEROED, LOAD THE"
2672 PRINT "MODEL ONTO THE STING. WHEN THE MODEL IS
MOUNTED, PRESS RETURN"
2673 INPUT "TO RECORD A NO FORCE ZERO READING";N
2690 PRINT:PRINT " ZD ZL ZY ZPM ZYM
ZRM ZAOA"
2700 STAT%=0: MODE%=0: STOR%=0: COUNT=100: RATE=500
2710 ADAPT%= 0: DEVICE%= 9: CHANLO%= 0: CTRL%= 0: CHANHI%=3
2720 CALL AINSC(ADAPT%,DEVICE%,CHANLO%,CHANHI%,CTRL%,MODE%
,STOR%,COUNT,RATE,DAT%(0),STAT%)
2730 ZD = 0:ZPM=0:ZL=0:ZYM=0
2740 IF STAT%<> 0 THEN PRINT USING "EXECUTION ERROR ###";
STAT%:END
2750 FOR J = 0 TO 396 STEP 4
2760 DAT(J)=(DAT%(J)/204.8)-10
2770 ZD =ZD + DAT(J)
2780 NEXT J
2790 ZD = ZD/100
2800 FOR J = 1 TO 397 STEP 4
2810 DAT(J)=(DAT%(J)/204.8)-10

```

Figure A.10 RUNS.BAS (cont.)



```

2820 ZL = ZL + DAT(J)
2830 NEXT J
2840 FOR J = 2 TO 398 STEP 4
2850 DAT(J)=(DAT%(J)/204.8)-10
2860 ZPM = ZPM + DAT(J)
2870 NEXT J
2880 FOR J = 3 TO 399 STEP 4
2890 DAT(J)=(DAT%(J)/204.8)-10
2900 ZYM = ZYM + DAT(J)
2910 NEXT J
2920 STAT%=0: MODE%=0: STOR%=0: COUNT=100: RATE=500
2930 ADAPT%= 1: DEVICE%= 9: CHANLO%= 0: CTRL%= 0: CHANHI%=2
2940 CALL AINSC(ADAPT%,DEVICE%,CHANLO%,CHANHI%,CTRL%,MODE%
,STOR%,COUNT,RATE,DAT1%(0),STAT%)
2950 ZY =0:ZRM=0:ZAOA=0
2960 IF STAT%<> 0 THEN PRINT USING "EXECUTION ERROR ###";
STAT%:END
2970 FOR J = 0 TO 297 STEP 3
2980 DAT1(J)=(DAT1%(J)/204.8)-10
2990 ZRM = ZRM + DAT1(J)
3000 NEXT J
3010 ZRM = ZRM/100
3020 FOR J = 1 TO 298 STEP 3
3030 DAT1(J)=(DAT1%(J)/204.8)-10
3040 ZY = ZY + DAT1(J)
3050 NEXT J
3051 FOR J = 2 TO 299 STEP 3
3052 DAT1(J)=(DAT1%(J)/204.8)-10
3053 ZAOA = ZAOA + DAT1(J)
3054 NEXT J
3060 ZL=ZL/100:ZPM=ZPM/100:ZYM=ZYM/100:ZY=ZY/100:ZAOA=ZAOA
/100
3070 LOCATE 11,1: PRINT USING "+#.###";ZD: LOCATE 11,10:
PRINT USING "+#.###";ZL
3080 LOCATE 11,19: PRINT USING "+#.###";ZY
3090 LOCATE 11,28: PRINT USING "+#.###";ZPM
3100 LOCATE 11,37: PRINT USING "+#.###";ZYM
3110 LOCATE 11,46: PRINT USING "+#.###";ZRM
3111 LOCATE 11,55: PRINT USING "+#.###";ZAOA
3120 REM
3130 PRINT:PRINT
3140 INPUT "AFTER PLACING ALL CAL SWITCHES TO + SETTING HIT
RETURN";X
3150 PRINT
3160 PRINT " CALD      CLL      CALY      CALPM      CALYM
CALRM      CALAOA"
3170 STAT%=0: MODE%=0: STOR%=0: COUNT=100: RATE=500
3180 ADAPT%= 0: DEVICE%= 9: CHANLO%= 0: CTRL%= 0: CHANHI%=3
3190 CALL AINSC(ADAPT%,DEVICE%,CHANLO%,CHANHI%,CTRL%,MODE%
,STOR%,COUNT,RATE,DAT%(0),STAT%)

```

Figure A.10 RUNS.BAS (cont.)



```

3200 CALD=0:CLL=0:CALYM=0:CALPM=0
3210 IF STAT%<> 0,THEN PRINT USING "EXECUTION ERROR ###"
      ;STAT%:END
3220 FOR J = 0 TO 396 STEP 4
3230 DAT(J)=(DAT%(J)/204.8)-10
3240 CALD =CALD + DAT(J)
3250 NEXT J
3260 CALD = CALD/100
3270 FOR J = 1 TO 397 STEP 4
3280 DAT(J)=(DAT%(J)/204.8)-10
3290 CLL = CLL + DAT(J)
3300 NEXT J
3310 FOR J = 2 TO 398 STEP 4
3320 DAT(J)=(DAT%(J)/204.8)-10
3330 CALPM = CALPM + DAT(J)
3340 NEXT J
3350 FOR J = 3 TO 399 STEP 4
3360 DAT(J)=(DAT%(J)/204.8)-10
3370 CALYM = CALYM + DAT(J)
3380 NEXT J
3390 STAT%=0:  MODE%=0: STOR%=0: COUNT=100: RATE=500
3400 ADAPT%= 1: DEVICE%= 9: CHANLO%= 0: CTRL%= 0: CHANHI%=2
3410 CALL AINSC(ADAPT%,DEVICE%,CHANLO%,CHANHI%,CTRL%,MODE%
      ,STOR%,COUNT,RATE,DAT1%(0),STAT%)
3420 CALY =0:CALRM=0:CALAOA=0
3430 IF STAT%<> 0 THEN PRINT USING "EXECUTION ERROR ###";
      STAT%:END
3440 FOR J = 0 TO 297 STEP 3
3450 DAT1(J)=(DAT1%(J)/204.8)-10
3460 CALRM = CALRM + DAT1(J)
3470 NEXT J
3480 CALRM = CALRM/100
3490 FOR J = 1 TO 298 STEP 3
3500 DAT1(J)=(DAT1%(J)/204.8)-10
3510 CALY = CALY + DAT1(J)
3520 NEXT J
3521 FOR J = 2 TO 299 STEP 3
3522 DAT1(J)=(DAT1%(J)/204.8)-10
3523 CALAOA = CALAOA + DAT1(J)
3524 NEXT J
3530 CLL=CLL/100:CALPM=CALPM/100:CALYM=CALYM/100:CALY=CALY
      /100:CALAOA=CALAOA/100
3540 LOCATE 18,1: PRINT USING "+#.###";CALD
3550 LOCATE 18,10: PRINT USING "+#.###";CLL
3560 LOCATE 18,19: PRINT USING "+#.###";CALY
3570 LOCATE 18,28: PRINT USING "+#.###";CALPM
3580 LOCATE 18,37: PRINT USING "+#.###";CALYM
3590 LOCATE 18,46: PRINT USING "+#.###";CALRM
3591 LOCATE 18,55: PRINT USING "+#.###";CALAOA
3592 INPUT "PRESS RETURN TO CONTINUE";N

```

Figure A.10 RUNS.BAS (cont.)

```

3593 CLS
3600 PRINT: PRINT "REPLACE THE CAL SWITCHES TO THE CENTER
      POSITION"
3610 PRINT "AFTER YOU HAVE GOTTEN THE WIND TUNNEL UP TO
      SPEED AND ARE READY"
3620 PRINT "TO RECORD DATA PRESS RETURN.  ONCE THE HEADINGS
      ARE PRINTED THE"
3630 PRINT "F2 KEY WILL RECORD THE DATA.  THE F1 KEY WILL
      SAVE THE DATA AND "
3640 PRINT "RERUN YOU TO THE MAIN MENU.  YOU CAN TAKE READ
      INGS FOR ANY ANGLE"
3650 PRINT "OF ATTACK BETWEEN +10 AND -8 DEGREES."
3651 PRINT
3652 PRINT "THIS PROGRAM CORRECTS FOR DRIFT IN THE BALANCE
      AND AMPLIFIERS."
3653 PRINT "YOUR FIRST AND LAST DATA POINTS SHOULD BE TAKEN
      AT ZERO ANGLE OF"
3654 PRINT "ATTACK.  ALSO, DO NOT TAKE MORE THAN ONE DATA
      POINT FOR THE SAME "
3655 PRINT "ANGLE OF ATTACK EXCEPT FOR YOUR FIRST AND LAST
      DATA POINT.  YOU"
3656 PRINT "ARE LIMITED TO 100 DATA POINTS.  REMEMBER, EACH
      RUN IS FOR ONE"
3657 PRINT "SPECIFIC 'Q' SETTING"
3660 INPUT "PRESS RETURN TO CONTINUE";N
3670 CLS
3680 PRINT " DRAG          LIFT          YAW          PITCH          YAW
      ROLL          AOA          TUNNEL"
3690 PRINT "
      MOM.          SPEED"
3700 SOAP = 0: N=4
3710 FOR K = 1 TO 100
3720 ON KEY(1) GOSUB 3820          'SET STOP FLAG
3730 ON KEY(2) GOSUB 3850          'RECORD DATA
3740 KEY(1) ON: KEY(2) ON
3750 IF SOAP = 2 THEN GOTO 3780
3760 IF SOAP = 1 THEN GOTO 4370
3770 GOTO 3720
3780 SOAP = 0
3790 NOD% = K
3800 NEXT K
3810 GOTO 4370
3820 REM SET STOP FLAG
3830 SOAP = 1
3840 RETURN
3850 REM STEPS TO RECORD DATA
3860 STAT%=0:  MODE%=0:  STOR%=0:  COUNT=100:  RATE=500
3870 ADAPT%= 0:  DEVICE%= 9:  CHANLO%= 0:  CTRL%= 0:  CHANHI%=3
3880 CALL AINSC(ADAPT%,DEVICE%,CHANLO%,CHANHI%,CTRL%,MODE%
      ,STOR%,COUNT,RATE,DAT%(0),STAT%)

```

Figure A.10 RUNS.BAS (cont.)

```

3890 D(K)=0:L(K)=0:YM(K)=0:PM(K)=0
3900 IF STAT%<> 0,THEN PRINT USING "EXECUTION ERROR ###";
      STAT%:END
3910 FOR J = 0 TO 396 STEP 4
3920 DAT(J)=(DAT%(J)/204.8)-10
3930 D(K) =D(K) + DAT(J)
3940 NEXT J
3950 D(K) = D(K)/100
3960 FOR J = 1 TO 397 STEP 4
3970 DAT(J)=(DAT%(J)/204.8)-10
3980 L(K) = L(K) + DAT(J)
3990 NEXT J
4000 FOR J = 2 TO 398 STEP 4
4010 DAT(J)=(DAT%(J)/204.8)-10
4020 PM(K) = PM(K) + DAT(J)
4030 NEXT J
4040 FOR J = 3 TO 399 STEP 4
4041 DAT(J)=(DAT%(J)/204.8)-10
4050 YM(K) = YM(K) + DAT(J)
4060 NEXT J
4070 STAT%=0: MODE%=0: STOR%=0: COUNT=100: RATE=500
4080 ADAPT%= 1: DEVICE%= 9: CHANLO%= 0: CTRL%= 0: CHANHI%=2
4090 CALL AINSC(ADAPT%,DEVICE%,CHANLO%,CHANHI%,CTRL%,MODE%
      ,STOR%,COUNT,RATE,DAT1%(0),STAT%)
4100 Y(K) =0:RM(K)=0: AOA(K)=0
4110 IF STAT%<> 0 THEN PRINT USING "EXECUTION ERROR ###";
      STAT%:END
4120 FOR J = 0 TO 297 STEP 3
4130 DAT1(J)=(DAT1%(J)/204.8)-10
4140 RM(K) = RM(K) + DAT1(J)
4150 NEXT J
4160 RM(K) = RM(K)/100
4170 FOR J = 1 TO 298 STEP 3
4180 DAT1(J)=(DAT1%(J)/204.8)-10
4190 Y(K) = Y(K) + DAT1(J)
4200 NEXT J
4210 FOR J = 2 TO 299 STEP 3
4220 DAT1(J)=(DAT1%(J)/204.8)-10
4230 AOA(K) = AOA(K) + DAT1(J)
4240 NEXT J
4250 AOA(K)=AOA(K)/100:L(K)=L(K)/100:PM(K)=PM(K)/100:YM(K)
      =YM(K)/100:Y(K)=Y(K)/100
4255 B = AOA(K) - ZAOA
4256 AOA(K) = (5.8469*B) + (.0077583*(B^2))
4260 IF N> 23 THEN N=4:CLS:PRINT " DRAG          LIFT          YAW
      PITCH          YAW          ROLL          AOA          TUNNEL":PRINT "
      MOM.          MOM.          MOM.          SPEED"
4270 LOCATE N,1: PRINT USING "+#.###";D(K)
4280 LOCATE N,10: PRINT USING "+#.###";L(K)
4290 LOCATE N,19: PRINT USING "+#.###";Y(K)

```

Figure A.10 RUNS.BAS (cont.)

```

4300 LOCATE N,28: PRINT USING "+#.###";PM(K)
4310 LOCATE N,37: PRINT USING "+#.###";YM(K)
4320 LOCATE N,46: PRINT USING "+#.###";RM(K)
4330 LOCATE N,55: PRINT USING "+#.###";AOA(K)
4340 N=N+1
4350 SOAP = 2
4360 RETURN
4370 SOAP = 0
4371 '---CORRECT FOR DRIFT-----
4372 DIFFL=(L(NOD%)-L(1)): DIFFD=(D(NOD%)-D(1)): DIFFY=(Y(
NOD%)-Y(1))
4373 DIFFPM=(PM(NOD%)-PM(1)): DIFFYM=(YM(NOD%)-YM(1)): DIFFR
M=(RM(NOD%)-RM(1)): DIFFAOA=(AOA(NOD%)-AOA(1))
4374 D=NOD%-1
4375 CORL=DIFFL/D:CORD=DIFFD/D:CORY=DIFFY/D:CORPM=DIFFPM/D
:CORYM=DIFFYM/D:CORRM=DIFFRM/D:CORAOA=DIFFAOA/D
4376 A=1
4377 FOR K = 2 TO NOD%
4378   L(K)=L(K)-(A*CORL)
4379   D(K)=D(K)-(A*CORD)
4380   Y(K)=Y(K)-(A*CORY)
4381   PM(K)=PM(K)-(A*CORPM)
4382   YM(K)=YM(K)-(A*CORYM)
4383   RM(K)=RM(K)-(A*CORRM)
4385   A = A+1
4386 NEXT K
4387 '-----SAVE DATA TO FILE-----
4390 CLS: PRINT
4400 INPUT "WHAT IS THE NAME FOR THE FILE TO STORE THE RAW
DATA";FILES$
4410 FILES$=FD$+FILES$
4420 OPEN FILES$ FOR OUTPUT AS #1
4421 WRITE #1,NOD%,CONFIG$,CONF
4430 WRITE #1,Q,W
4470 WRITE #1,ZL,ZD,ZY,ZPM,ZYM,ZRM,ZAOA
4480 WRITE #1,CLL,CALD,CALY,CALPM,CALYM,CALRM,CALAOA
4490   FOR J=1 TO NOD%
4500     WRITE #1,L(J),D(J),Y(J),PM(J),YM(J),RM(J),AOA(J)
4510   NEXT J
4520 CLOSE #1
4521 CLS:PRINT "DO YOU WANT TO TAKE ANOTHER SET OF DATA
POINTS FOR THE SAME"
4522 INPUT "CONFIGURATION BUT A DIFFERENT 'Q' SETTING (Y/N
)";ANS$
4523 IF ANS$="Y" OR ANS$="y" THEN GOTO 4524 ELSE GOTO 4530
4524 PRINT: INPUT "WHAT IS THE 'Q' VALUE FOR THIS RUN";Q
4525 GOTO 3610
4530 '----RETURN TO MAIN PROGRAM
4531 COMMON PD$,FD$,DX%
4532 CHAIN PD$+"MAIN.BAS",2110

```

Figure A.10 RUNS.BAS (cont.)



```

4540 REM----SUBROUTINES FOR CONFIGURATION MARKING-----
4550 IF Z$ = "Y" OR Z$ = "y" THEN GOTO 4590
4560 CONF = 10
4570 CONFIG$="ATTACK NOSE/STRAIGHT TAIL WITHOUT GEAR"
4580 GOTO 4610
4590 CONF = 15
4600 CINFOG$="ATTACK NOSE/STRAIGHT TAIL WITH GEAR"
4610 RETURN
4620 IF Z$ = "Y" OR Z$ = "y" THEN GOTO 4660
4630 CONF = 20
4640 CONFIG$="ATTACK NOSE/LOW TAIL WITHOUT GEAR"
4650 GOTO 4680
4660 CONF = 25
4670 CINFOG$="ATTACK NOSE/LOW TAIL WITH GEAR"
4680 RETURN
4690 IF Z$ = "Y" OR Z$ = "y" THEN GOTO 4730
4700 CONF = 30
4710 CONFIG$="ATTACK NOSE/HIGH TAIL WITHOUT GEAR"
4720 GOTO 4740
4730 CONF = 35: CINFOG$="ATTACK NOSE/HIGH TAIL WITH GEAR"
4740 RETURN
4750 IF Z$ = "Y" OR Z$ = "y" THEN GOTO 4790
4760 CONF = 40
4770 CONFIG$="SMOOTH NOSE/STRAIGHT TAIL WITHOUT GEAR"
4780 GOTO 4810
4790 CONF = 45
4800 CINFOG$="SMOOTH NOSE/STRAIGHT TAIL WITH GEAR"
4810 RETURN
4820 IF Z$ = "Y" OR Z$ = "y" THEN GOTO 4850
4830 CONF=50:CONFIG$="SMOOTH NOSE/LOW TAIL WITHOUT GEAR"
4840 GOTO 4860
4850 CONF = 55: CINFOG$="SMOOTH NOSE/LOW TAIL WITH GEAR"
4860 RETURN
4870 IF Z$ = "Y" OR Z$ = "y" THEN GOTO 4900
4880 CONF=60:CONFIG$="SMOOTH NOSE/HIGH TAIL WITHOUT GEAR"
4890 GOTO 4910
4900 CONF = 65: CINFOG$="SMOOTH NOSE/HIGH TAIL WITH GEAR"
4910 RETURN
4920 IF Z$ = "Y" OR Z$ = "y" THEN GOTO 4960
4930 CONF = 70
4940 CONFIG$="ATTACK NOSE/STRAIGHT TAIL WITHOUT GEAR"
4950 GOTO 4980
4960 CONF = 75
4970 CINFOG$="ATTACK NOSE/STRAIGHT TAIL WITH GEAR"
4980 RETURN
4990 IF Z$ = "Y" OR Z$ = "y" THEN GOTO 5020
5000 CONF = 80:CONFIG$="BLUNT NOSE/LOW TAIL WITHOUT GEAR"
5010 GOTO 5030
5020 CONF = 85: CINFOG$="BLUNT NOSE/LOW TAIL WITH GEAR"
5030 RETURN

```

Figure A.10 RUNS.BAS (cont.)



```
5040 IF Z$ = "Y" OR Z$ = "y" THEN GOTO 5070
5050 CONF=90:CONFIG$="BLUNT NOSE/HIGH TAIL WITHOUT GEAR"
5060 GOTO 5080
5070 CONF = 95: CCONFIG$="SMOOT NOSE/HIGH TAIL WITH GEAR"
5080 RETURN
```

Figure A.10 RUNS.BAS (cont.)

```

10 REM----RED.BAS      (CONVERT RAW COUNTS TO FORCES)----
20 REM
30 REM
40 COLOR 15,1:KEY OFF: CLS
45 DIM L(100),L1(100),L2(100),D(100),D1(100),D2(100),
    (100),Y1(100),Y2(100)
46 DIM PM(100),PM1(100),PM2(100),YM(100),YM1(100),YM2(10
    0),RM(100),RM1(100),RM2(100)
47 DIM LF(100),DF(100),AOA(100)
50 PRINT:PRINT"WHAT IS THE NAME OF THE FILE THAT CONTAINS
    THE RAW DATA"
60 INPUT"THAT YOU WISH TO CONVERT";FILES$
70 FILES$=FD$+FILES$
80 '-----READ IN RAW DATA FILE-----
90 OPEN FILES$ FOR INPUT AS #1
100 INPUT #1,NOD%,CONFIG$,CONF
110 INPUT #1,Q,W
150 INPUT #1,ZL,ZD,ZY,ZPM,ZYM,ZRM,ZAOA
160 INPUT #1,CLL,CALD,CALY,CALPM,CALYM,CALRM,CALAOA
170   FOR J = 1 TO NOD%
180     INPUT #1,L(J),D(J),Y(J),PM(J),YM(J),RM(J),AOA(J)
190   NEXT J
200 CLOSE #1
210 PRINT:PRINT"PLEASE WAIT WHILE PERFORMING CONVERSION"
211 PRINT "THE CONVERSION WILL TAKE APPROXIMATELY TEN MIN
    UTES FOR "
212 PRINT "TWENTY DATA POINTS"
220 '-----READ IN CALIBRATION CONSTANTS-----
221 OPEN "C:CONST" FOR INPUT AS #1
222 INPUT #1,INCALL,INCALD,INCALY,INCALPM,INCALYM,INCALRM
240 INPUT #1,K1LPOS,K2LPOS,K1DPOS,K2DPOS,K1YPOS,K2YPOS
250 INPUT #1,K1PMPOS,K2PMPOS,K1YMPOS,K2YMPOS,K1RMPOS,
    K2RMPOS
260 INPUT #1,K1LNEG,K2LNEG,K1DNEG,K2DNEG,K1YNEG,K2YNEG
270 INPUT #1,K1PMNEG,K2PMNEG,K1YMNEG,K2YMNEG,K1RMNEG,
    K2RMNEG
280 INPUT #1,DDDL1P,DDDL2P,DYDL1P,DYDL2P,DPMDL1P,DPMDL2P,
    DYMDL1P,DYMDL2P
290 INPUT #1,DRMDL1P,DRMDL2P
300 INPUT #1,DLDD1P,DLDD2P,DYDD1P,DYDD2P,DPMDD1P,DPMDD2P,
    DYMDD1P,DYMDD2P
310 INPUT #1,DRMDD1P,DRMDD2P
320 INPUT #1,DLDY1P,DLDY2P,DDDY1P,DDDY2P,DPMDY1P,DPMDY2P,
    DYMDY1P,DYMDY2P
330 INPUT #1,DRMDY1P,DRMDY2P
340 INPUT #1,DLDP1P,DLDP2P,DDDP1P,DDDP2P,DYDP1P,DYDP
    2P,DYMDP1P,DYMDP2P
350 INPUT #1,DRMDP1P,DRMDP2P
360 INPUT #1,DLDY1P,DLDY2P,DDDY1P,DDDY2P,DYDY1P,DYDY
    2P,DPMDY1P,DPMDY2P

```

Figure A.11 RED.BAS - Data Reduction Program

```

370 INPUT #1, DRMDYM1P, DRMDYM2P
380 INPUT #1, DLDRM1P, DLDRM2P, DDRM1P, DDRM2P, DYDRM1P, DYDR
M2P, DPMDRM1P, DPMDRM2P
390 INPUT #1, DYMDRM1P, DYMDRM2P
400 INPUT #1, DDDL1N, DDDL2N, DYDL1N, DYDL2N, DPMDL1N, DPMDL2N,
DYMDL1N, DYMDL2N
410 INPUT #1, DRMDL1N, DRMDL2N
420 INPUT #1, DLDD1N, DLDD2N, DYDD1N, DYDD2N, DPMDD1N, DPMDD2N,
DYMDD1N, DYMDD2N
430 INPUT #1, DRMDD1N, DRMDD2N
440 INPUT #1, DLDY1N, DLDY2N, DDDY1N, DDDY2N, DPMDY1N, DPMDY2N,
DYMDY1N, DYMDY2N
450 INPUT #1, DRMDY1N, DRMDY2N
460 INPUT #1, DLDPM1N, DLDPM2N, DDDPM1N, DDDPM2N, DYDPM1N, DYDP
M2N, DYMDPM1N
470 INPUT #1, DYMDPM2N, DRMDPM1N, DRMDPM2N
480 INPUT #1, DLDYM1N, DLDYM2N, DDDYM1N, DDDYM2N, DYDYM1N, DYDY
M2N, DPMDYM1N
490 INPUT #1, DPMDYM2N, DRMDYM1N, DRMDYM2N
500 INPUT #1, DLDRM1N, DLDRM2N, DDRM1N, DDRM2N, DYDRM1N, DYDR
M2N, DPMDRM1N
510 INPUT #1, DPMDRM2N, DYMDRM1N, DYMDRM2N
520 CLOSE #1
530 '-----CONVERT RAW COUNTS TO FORCES-----
540 FOR J = 1 TO NOD%
550 A = ((INCALL/(CLL-ZL)) * (L(J)-ZL))
560 B = ((INCALD/(CALD-ZD)) * (D(J)-ZD))
570 C = ((INCALY/(CALY-ZY)) * (Y(J)-ZY))
580 D = ((INCALPM/(CALPM-ZPM)) * (PM(J)-ZPM))
590 E = ((INCALYM/(CALYM-ZYM)) * (YM(J)-ZYM))
600 F = ((INCALRM/(CALRM-ZRM)) * (RM(J)-ZRM))
610 IF A <= 0 THEN K1=K1LNEG:K2=K2LNEG ELSE K1=K1LPOS
:K2=K2LPOS
615 L(J) = (K1*A) + (K2*A^2)
620 IF B <= 0 THEN K1=K1DNEG:K2=K2DNEG ELSE K1=K1DPOS
:K2=K2DPOS
625 D(J) = (K1*B) + (K2*B^2)
630 IF C <= 0 THEN K1=K1YNEG:K2=K2YNEG ELSE K1=K1YPOS
:K2=K2YPOS
635 Y(J) = (K1*C) + (K2*C^2)
640 IF D <= 0 THEN K1=K1PMNEG:K2=K2PMNEG ELSE K1=K1
PMPOS:K2=K2PMPOS
645 PM(J) = (K1*D) + (K2*D^2)
650 IF E <= 0 THEN K1=K1YMNEG:K2=K2YMNEG ELSE K1=K1
YMPOS:K2=K2YMPOS
655 YM(J) = (K1*E) + (K2*E^2)
660 IF F <= 0 THEN K1=K1RMNEG:K2=K2RMNEG ELSE K1=K1
RMPOS:K2=K2RMPOS
665 RM(J) = (K1*F) + (K2*F^2)
670 NEXT J

```

Figure A.11 RED.BAS (cont.)

```

680 '-----PERFORM INTERACTON CORRECTIONS-----
690 FOR K = 1 TO NOD%
695 '-----FIRST CONSTANT DETERMINATION-----
700 IF L(K) > 0 THEN GOTO 710 ELSE GOTO 720
710 DD1=DDDL1P:DD6=DDDL2P:DY1=DYDL1P:DY6=DYDL2P:DPM1=DP
MDL1P:DPM6=DPMDL2P:DYM1=DYMDL1P:DYM6=DYMDL2P:DRM1=D
RMDL1P:DRM6=DRMDL2P
715 GOTO 730
720 DD1=DDDL1N:DD6=DDDL2N:DY1=DYDL1N:DY6=DYDL2N:DPM1=DP
MDL1N:DPM6=DPMDL2N:DYM1=DYMDL1N:DYM6=DYMDL2N:DRM1=D
RMDL1N:DRM6=DRMDL2N
730 IF D(K) > 0 THEN GOTO 740 ELSE GOTO 750
740 DL1=DLDD1P:DL6=DLDD2P:DY2=DYDD1P:DY7=DYDD2P:DPM2=DP
MDD1P:DPM7=DPMDD2P:DYM2=DYMD1P:DYM7=DYMD2P:DRM2=D
RMDD1P:DRM7=DRMDD2P
745 GOTO 760
750 DL1=DLDD1N:DL6=DLDD2N:DY2=DYDD1N:DY7=DYDD2N:DPM2=DP
MDD1N:DPM7=DPMDD2N:DYM2=DYMD1N:DYM7=DYMD2N:DRM2=D
RMDD1N:DRM7=DRMDD2N
760 IF Y(K) > 0 THEN GOTO 770 ELSE GOTO 780
770 DL2=DLDY1P:DL7=DLDY2P:DD2=DDDY1P:DD7=DDDY2P:DPM3=DP
MDY1P:DPM8=DPMDY2P:DYM3=DYMDY1P:DYM8=DYMDY2P:DRM3=D
RMDY1P:DRM8=DRMDY2P
775 GOTO 790
780 DL2=DLDY1N:DL7=DLDY2N:DD2=DDDY1N:DD7=DDDY2N:DPM3=DP
MDY1N:DPM8=DPMDY2N:DYM3=DYMDY1N:DYM8=DYMDY2N:DRM3=D
RMDY1N:DRM8=DRMDY2N
790 IF PM(K) > 0 THEN GOTO 800 ELSE GOTO 810
800 DL3=DLDPM1P:DL8=DLDPM1P:DD3=DDDPM1P:DD8=DDDPM2P:DY3
=DYDPM1P:DY8=DYDPM2P:DYM4=DYMDPM1P:DYM9=DYMDPM2P:DR
M4=DRMDPM1P:DRM9=DRMDPM2P
805 GOTO 820
810 DL3=DLDPM1N:DL8=DLDPM1N:DD3=DDDPM1N:DD8=DDDPM2N:DY3
=DYDPM1N:DY8=DYDPM2N:DYM4=DYMDPM1N:DYM9=DYMDPM2N:DR
M4=DRMDPM1N:DRM9=DRMDPM2N
820 IF YM(K) > 0 THEN GOTO 830 ELSE GOTO 840
830 DL4=DLDYM1P:DL9=DLDYM2P:DD4=DDDYM1P:DD9=DDDYM2P:DY4
=DYDYM1P:DY9=DYDYM2P:DPM4=DPMDYM1P:DPM9=DPMDYM2P:DR
M5=DRMDYM1P:DRM10=DRMDYM2P
835 GOTO 850
840 DL4=DLDYM1N:DL9=DLDYM2N:DD4=DDDYM1N:DD9=DDDYM2N:DY4
=DYDYM1N:DY9=DYDYM2N:DPM4=DPMDYM1N:DPM9=DPMDYM2N:DR
M5=DRMDYM1N:DRM10=DRMDYM2N
850 IF RM(K) > 0 THEN GOTO 860 ELSE GOTO 870
860 DL5=DLDRM1P:DL10=DLDRM2P:DD5=DDDRM1P:DD10=DDDRM2P:D
Y5=DYDRM1P:DY10=DYDRM2P:DPM5=DPMDRM1P:DPM10=DPMDRM2
P:DYM5=DYMDRM1P:DYM10=DYMDRM2P
865 GOTO 880
870 DL5=DLDRM1N:DL10=DLDRM2N:DD5=DDDRM1N:DD10=DDDRM2N:D
Y5=DYDRM1N:DY10=DYDRM2N:DPM5=DPMDRM1N:DPM10=DPMDRM2

```

Figure A.11 RED.BAS (cont.)



```

      N:DYM5=DYMDRM1N:DYM10=DYMDRM2N
880  '-----FIRST INTERACTION CALCULATION-----
890      L1(K)=L(K)-(DL1*D(K))-(DL6*(D(K)^2))
900      D1(K)=D(K)-(DD1*L(K))-(DD6*(D(K)^2))
950  '-----SECOND CONSTANT DETERMINATION-----
960      IF L1(K) > 0 THEN GOTO 970 ELSE GOTO 980
970      DD1=DDDL1P:DD6=DDDL2P:DY1=DYDL1P:DY6=DYDL2P:DPM1=DP
      MDL1P:DPM6=DPMDL2P:DYM1=DYMDL1P:DYM6=DYMDL2P:DRM1=D
      RMDL1P:DRM6=DRMDL2P
975      GOTO 990
980      DD1=DDDL1N:DD6=DDDL2N:DY1=DYDL1N:DY6=DYDL2N:DPM1=DP
      MDL1N:DPM6=DPMDL2N:DYM1=DYMDL1N:DYM6=DYMDL2N:DRM1=D
      RMDL1N:DRM6=DRMDL2N
990      IF D1(K) > 0 THEN GOTO 1000 ELSE GOTO 1010
1000     DL1=DLDD1P:DL6=DLDD2P:DY2=DYDD1P:DY7=DYDD2P:DPM2=DP
      MDD1P:DPM7=DPMDD2P:DYM2=DYMDD1P:DYM7=DYMDD2P:DRM2=D
      RMDD1P:DRM7=DRMDD2P
1005     GOTO 1020
1010     DL1=DLDD1N:DL6=DLDD2N:DY2=DYDD1N:DY7=DYDD2N:DPM2=DP
      MDD1N:DPM7=DPMDD2N:DYM2=DYMDD1N:DYM7=DYMDD2N:DRM2=D
      RMDD1N:DRM7=DRMDD2N
1020     IF Y1(K) > 0 THEN GOTO 1030 ELSE GOTO 1040
1030     DL2=DLDY1P:DL7=DLDY2P:DD2=DDDY1P:DD7=DDDY2P:DPM3=DP
      MDY1P:DPM8=DPMDY2P:DYM3=DYMDY1P:DYM8=DYMDY2P:DRM3=D
      RMDY1P:DRM8=DRMDY2P
1035     GOTO 1050
1040     DL2=DLDY1N:DL7=DLDY2N:DD2=DDDY1N:DD7=DDDY2N:DPM3=DP
      MDY1N:DPM8=DPMDY2N:DYM3=DYMDY1N:DYM8=DYMDY2N:DRM3=D
      RMDY1N:DRM8=DRMDY2N
1050     IF PM1(K) > 0 THEN GOTO 1060 ELSE GOTO 1080
1060     DL3=DLDPM1P:DL8=DLDPM1P:DD3=DDDPM1P:DD8=DDDPM2P:DY3
      =DYDPM1P:DY8=DYDPM2P:DYM4=DYMDPM1P:DYM9=DYMDPM2P:DR
      M4=DRMDPM1P:DRM9=DRMDPM2P
1070     GOTO 1090
1080     DL3=DLDPM1N:DL8=DLDPM1N:DD3=DDDPM1N:DD8=DDDPM2N:DY3
      =DYDPM1N:DY8=DYDPM2N:DYM4=DYMDPM1N:DYM9=DYMDPM2N:DR
      M4=DRMDPM1N:DRM9=DRMDPM2N
1090     IF YM1(K) > 0 THEN GOTO 1100 ELSE GOTO 1110
1100     DL4=DLDYM1P:DL9=DLDYM2P:DD4=DDDYM1P:DD9=DDDYM2P:DY4
      =DYDYM1P:DY9=DYDYM2P:DPM4=DPMDYM1P:DPM9=DPMDYM2P:DR
      M5=DRMDYM1P:DRM10=DRMDYM2P
1105     GOTO 1120
1110     DL4=DLDYM1N:DL9=DLDYM2N:DD4=DDDYM1N:DD9=DDDYM2N:DY4
      =DYDYM1N:DY9=DYDYM2N:DPM4=DPMDYM1N:DPM9=DPMDYM2N:DR
      M5=DRMDYM1N:DRM10=DRMDYM2N
1120     IF RM1(K) > 0 THEN GOTO 1130 ELSE GOTO 1140
1130     DL5=DLDRM1P:DL10=DLDRM2P:DD5=DDDRM1P:DD10=DDDRM2P:D
      Y5=DYDRM1P:DY10=DYDRM2P:DPM5=DPMDRM1P:DPM10=DPMDRM2
      P:DYM5=DYMDRM1P:DYM10=DYMDRM2P
1135     GOTO 1150

```

Figure A.11 RED.BAS (cont.)



```

1140    DL5=DLDRM1N:DL10=DLDRM2N:DD5=DDDRM1N:DD10=DDDRM2N:D
      Y5=DYDRM1N:DY10=DYDRM2N:DPM5=DPMDRM1N:DPM10=DPMDRM2
      N:DYM5=DYMDRM1N:DYM10=DYMDRM2N
1150 '-----SECOND INTERACTION CALCULATION-----
1160    L2(K)=L(K)-(DL1*D1(K))-(DL6*(D1(K)^2))
1170    D2(K)=D(K)-(DD1*L1(K))-(DD6*(D1(K)^2))
1220 '-----COMPARE INTERACTION CALCULATIONS-----
1230    DFL=ABS(L1(K)-L2(K)):DFD=ABS(D1(K)-D2(K))
1250    IF DFL < .0005 AND DFD < .0005 THEN GOTO 1330
1260    IF DFL > .0005 THEN L1(K)=L2(K)
1270    IF DFD > .0005 THEN D1(K)=D2(K)
1320    GOTO 960
1330    L(K)=L2(K):D(K)=D2(K)
1340    NEXT K
2330 '-----PERFORM WEIGHT TARE CORRECTIONS-----
2335 '--DRAG AND LIFT NEED TO BE CORRECTED FOR AXIS ORIENT
      ATION--
2340    FOR K = 1 TO NOD%
2350        ALPHA = AOA(K)*(3.141593/180) 'CONVERT TO RADIANS
2360        DF(K)=((( -1*D(K))-(W*SIN(ALPHA)))*COS(ALPHA)) + (((
      -1*L(K))-(W*COS(ALPHA)))*SIN(ALPHA))
2370        LF(K)=((( -1*L(K))-(W*COS(ALPHA)))*COS(ALPHA)) - (((
      -1*L(K))-(W*SIN(ALPHA)))*SIN(ALPHA))
2380    NEXT K
2390 '-----SAVE REDUCED DATA TO FILE-----
2395    CLS:PRINT "DATA REDUCTION COMPLETE, SAVING DATA TO ";
      FILE$
2400    OPEN FILE$ FOR OUTPUT AS #2
2410    WRITE #2,NOD%,CONFIG$,CONF
2420    WRITE #2,Q,W
2421    WRITE #2,ZL,ZD,ZY,ZPM,ZYM,ZRM,ZAOA
2422    WRITE #2,CLL,CALD,CALY,CALPM,CALYM,CALRM,CALAOA
2430        FOR J = 1 TO NOD%
2450            WRITE #2,LF(J),DF(J),Y(J),PM(J),YM(J),RM(J),AOA(J)
2460        NEXT J
2470 '-----RETURN TO MAIN PROGRAM-----
2480    COMMON PD$,FD$,DX%
2490    CHAIN PD$+"MAIN.BAS",2110
2500 '-----END OF REDUCTION-----

```

Figure A.11 RED.BAS (cont.)

```

10  '-----DATA EDITOR-----
20  GOSUB 180
30  COLOR 15,1,7: KEY OFF: CLS
40  LOCATE 5,34: PRINT "*OPTIONS MENU*"
50  PRINT
60  PRINT
70  PRINT TAB(30) "1.  CREATE A NEW FILE"
80  PRINT
90  PRINT TAB(30) "2.  EDIT EXISTING FILE"
100 PRINT
110 PRINT TAB(30) "3.  INCREASE NUMBER OF TEST POINTS"
120 PRINT TAB(30) "    IN AN EXISTING FILE"
130 PRINT
140 PRINT TAB(30) "4.  EXIT DATA EDITOR"
150 LOCATE 20,5: INPUT "ENTER YOUR CHOICE (1,2,3,4)";REP%
160 ON REP% GOSUB 390,280,2530,480
170 GOTO 30
180 '-----INITIALIZING CONSTANTS-----
190 OPTION BASE 1: KEY OFF
200 DIM LF(100),DF(100),YF(100),PM(100),RM(100)
210 DIM YM(100),AOA(100),COMMAND(10)
220 BLANK2$ = "
230 BLANK1$ = "
240 BLANK$ = "
250 COMMAND$(1) = "c": COMMAND$(2) = "r": COMMAND$(3) = "d"
260 COMMAND$(4) = "e": COMMAND$(5) = "s": COMMAND$(6) = "u": COMMAND$(7) = "q"
270 RETURN
280 '-----EDIT A FILE-----
290 CLS: COLOR 15,1,7
300 LOCATE 5,10: INPUT "ENTER YOUR FILE NAME";FILE$
305 FILE$ = FD$+FILE$
310 GOSUB 2680 ' READ IN FILE
320 PAGE% = 1: COL% = 1: SAVED% = 0: OLDXPOS% = 0:
    OLDYPOS% = 0
330 GOSUB 1050 'PRINT BACKGROUND LINES
340 ROW% = 3: GOSUB 1740 : GOSUB 1900 'HIGHLIGHT
    FIRST ROW AND COLUMN
350 LOCATE 23,30: PRINT "LISTING": BEEP
360 GOSUB 1430 'PRINT COLUMNS 1-7 AND Q VALUE
370 LOCATE 23,20: PRINT BLANK2$
380 GOTO 470
390 '-----CREATE A FILE-----
400 COLOR 15,1,7: CLS
410 LOCATE 5,10: INPUT "ENTER YOUR FILE NAME";FILE$
415 FILE$ = FD$ + FILE$
420 LOCATE 7,10: INPUT "ENTER TEST CONFIGURATION";CONFIG$
430 LOCATE 9,10: INPUT "ENTER THE NUMBER OF TEST POINTS
    PER RUN";NOD%

```

Figure A.12 ADATA.BAS - On-Screen Data Editor

```

440 PAGE% = 1: COL% = 1: SAVED% = 0: OLDXPOS% = 0:
    OLDYPOS% = 0
450 GOSUB 1050 'PRINT BACKGROUND LINES
460 ROW% = 3: GOSUB 1740: GOSUB 1900 'HIGHLIGHT
    FIRST ROW AND COLUMN
470 GOSUB 490 ' INSERT NEW DATA
480 COMMON FD$,PD$,DX%
481 CHAIN PD$+"MAIN.BAS",2110
482 RETURN
490 '-----CHANGE OR INSERT DATA-----
500 LOCATE 23,12: PRINT BLANK$
510 LOCATE 23,12: INPUT REP$: IF REP$ = "" THEN GOTO 530
520 GOTO 570
530 LOCATE 23,12: PRINT BLANK$: LOCATE 23,12: PRINT
    "INVALID COMMAND": BEEP
540 FOR I = 1 TO 500 STEP 1
550 NEXT I
560 GOTO 500
570 REP2$ = RIGHT$(REP$,1)
580 T1% = ASC(REP2$)
590 IF T1% >= 43 AND T1% <= 57 THEN GOTO 650
600 T1% = T1% OR 32: REP2$ = CHR$(T1%)
610 GOSUB 2000
620 IF VALID% = 0 THEN GOTO 500 ELSE VALID% = 0
630 ON FLAG% GOSUB 1780,1670,2080,2340,2770,2170,2260
640 IF REP2$ <> "e" THEN GOTO 500 ELSE GOTO 1040
650 WHILE REP2$ <> "e"
660 NEWDATA = VAL(REP$)
670 IF QUIT% = 1 OR OLDXPOS% = 0 THEN QUIT% = 0: GOTO
    700 ELSE
680 LOCATE OLDXPOS%,OLDYPOS%,0
690 PRINT USING "####.##";OLDDATA
700 LOCATE 23,12: PRINT BLANK$
710 R% = ROW% - 2
720 IF COL% = 1 THEN LF(R%+18*(PAGE%-1))= NEWDATA:
    YPOS% = 7: GOTO 790: ELSE
730 IF COL% = 2 THEN DF(R%+18*(PAGE%-1))=NEWDATA: YPOS%
    = 18: GOTO 790: ELSE
740 IF COL% = 3 THEN YF(R%+18*(PAGE%-1))=NEWDATA: YPOS%
    = 29: GOTO 790: ELSE
750 IF COL% = 4 THEN PM(R%+18*(PAGE%-1))=NEWDATA: YPOS%
    = 40: GOTO 790: ELSE
760 IF COL% = 5 THEN RM(R%+18*(PAGE%-1))=NEWDATA: YPOS%
    = 51: GOTO 790: ELS
770 IF COL% = 6 THEN YM(R%+18*(PAGE%-1))=NEWDATA: YPOS%
    = 62: GOTO 790: ELS
780 IF COL% =7 THEN AOA(R%+18*(PAGE%-1))=NEWDATA: YPOS%
    = 71: GOTO 790: ELS
790 XPOS% = ROW%
800 LOCATE XPOS%,YPOS%: COLOR 0,10

```

Figure A.12 ADATA.BAS (cont.)

```

810 PRINT USING "####.##"; NEWDATA: MODIFIED% = 1
820 SAVED% = 0: COLOR 15,1,7
830 OLDYPOS% = YPOS%: OLDXPOS% = XPOS%: OLDDATA =
  NEWDATA
840 FWD% = 1
850 I% = ROW%+1: GOSUB 1690 'HIGHLIGHT NEW ROW
860 IF I% > NOD%+2 THEN FWD% = 1 ELSE FWD% = 0
870 IF I% > 20 THEN FWD% = 1 ELSE FWD% = 0
880 GOSUB 1800 'HIGHLIGHT NEW ROW
890 COLOR 15,1,7
900 LOCATE 23,12: PRINT BLANK$
910 LOCATE 23,12: INPUT REP$: IF REP$ = "" THEN GOTO 930
920 GOTO 950
930 LOCATE 23,12: PRINT BLANK$: LOCATE 23,12: PRINT
  "INVALID COMMAND": BEEP
940 GOTO 900
950 REP2$ = RIGHT$(REP$,1)
960 T1% = ASC(REP2$)
970 IF T1% >= 43 AND T1% <= 57 THEN GOTO 650
980 T1% = T1% OR 32: REP2$ = CHR$(T1%)
990 GOSUB 2000 'CHECK COMMANDS
1000 IF VALID% = 0 THEN GOTO 500 ELSE VALID% = 0
1010 ON FLAG% GOSUB 1780,1670,2080,2340,2770,2170,2260
  'COMMAND SUBROUTINES
1020 IF REP2$ <> "e" THEN GOTO 900 ELSE GOTO 1030
1030 WEND
1040 RETURN
1050 '-----PRINT BACKGROUND LINES-----
1060 COLOR 15,1,7
1070 CLS
1080 LOCATE 2,1
1090 FOR I% = 1 TO 80 : PRINT CHR$(220);: NEXT
1100 LOCATE 1,9: PRINT "LIFT"
1110 LOCATE 1,20: PRINT "DRAG"
1120 LOCATE 1,32: PRINT "YAW"
1130 LOCATE 1,41: PRINT "PITCH"
1140 LOCATE 1,53: PRINT "ROLL"
1150 LOCATE 1,62: PRINT "YAW M."
1160 LOCATE 1,74: PRINT "AOA"
1170 LOCATE 21,1
1180 FOR I% = 1 TO 80 : PRINT CHR$(220);: NEXT
1190 FOR I% = 1 TO 22
1200 LOCATE I%,1: PRINT CHR$(222)
1210 LOCATE I%,80: PRINT CHR$(222)
1220 NEXT
1230 FOR I% = 1 TO 21
1240 LOCATE I%,14: PRINT CHR$(179)
1250 LOCATE I%,25: PRINT CHR$(179)
1260 LOCATE I%,36: PRINT CHR$(179)
1270 LOCATE I%,47: PRINT CHR$(179)

```

Figure A.12 ADATA.BAS (cont.)



```

1280     LOCATE I%,58: PRINT CHR$(179)
1290     LOCATE I%,69: PRINT CHR$(179)
1300 NEXT
1310 FOR I% = 1 TO 18
1320     LOCATE I%+2,2
1330     PRINT USING "###";I%+18*(PAGE%-1);: PRINT ":"
1340 NEXT
1350 COLOR 15,4
1360 LOCATE 22,15: PRINT "C COLUMN  R ROW  D DOWN  E EXIT"
1370 LOCATE 22,46: PRINT "  S SAVE    U UP    Q TUNNEL
      SPEED"
1380 COLOR 14,0: LOCATE 23,44: PRINT CONFIG$
1390 COLOR 15,1,7
1400 LOCATE 22,2: PRINT "[Q =": LOCATE 22,12: PRINT "]"
1410 LOCATE 23,3: PRINT "COMMAND :"
1420 RETURN
1430 '-----PRINT COLUMNS 1-7 AND Q VALUE-----
1440 FOR I% = 1 TO 18
1450     LOCATE I%+2,7: PRINT USING "####.##";LF(I%+18*(PAGE%-1))
1460 NEXT
1470 FOR I% = 1 TO 18
1480     LOCATE I%+2,18: PRINT USING "####.##";DF(I%+18*(PAGE%-1))
1490 NEXT
1500 FOR I% = 1 TO 18
1510     LOCATE I%+2,29: PRINT USING "####.##";YF(I%+18*(PAGE%-1))
1520 NEXT
1530 FOR I% = 1 TO 18
1540     LOCATE I%+2,40: PRINT USING "####.##";PM(I%+18*(PAGE%-1))
1550 NEXT
1560 FOR I% = 1 TO 18
1570     LOCATE I%+2,51: PRINT USING "####.##";RM(I%+18*(PAGE%-1))
1580 NEXT
1590 FOR I% = 1 TO 18
1600     LOCATE I%+2,62: PRINT USING "####.##";YM(I%+18*(PAGE%-1))
1610 NEXT
1620 FOR I% = 1 TO 18
1630     LOCATE I%+2,71: PRINT USING "####.##";AOA(I%+18*(PAGE%-1))
1640 NEXT
1650 LOCATE 22,7:PRINT USING "###";Q
1660 RETURN
1670 '-----ROW INDEXING-----
1680 FWD% = VAL(REP$): IF FWD% = 0 THEN FWD% = 1
1690 OLDROW% = ROW%: ROW% = ROW% + FWD%

```

Figure A.12 ADATA.BAS (cont.)



```

1700 IF ROW% > NOD%+2 THEN ROW% = 3
1710 IF ROW% > 20 THEN ROW% = 3
1720 IF ROW% < 3 THEN ROW% = 3
1730 LOCATE OLDROW%,2: PRINT USING "###";OLDROW%-2+18*(PAGE%-1);: PRINT ":"
1740 COLOR 14,4: LOCATE ROW%,2
1750 PRINT USING "###";ROW%-2+18*(PAGE%-1);: PRINT ":"
1760 COLOR 15,1,7
1770 RETURN
1780 '-----COLUMN INDEXING-----
1790 FWD% = VAL(REP$): IF FWD% = 0 THEN FWD% = 1
1800 OLDCOL% = COL%: COL% = COL% + FWD%
1810 IF COL% > 7 THEN COL% = 1
1820 IF COL% < 1 THEN COL% = 7
1830 IF OLDCOL% = 1 THEN LOCATE 1,9: PRINT "LIFT": GOTO 1900 ELSE
1840 IF OLDCOL% = 2 THEN LOCATE 1,20: PRINT "DRAG": GOTO 1900 ELSE
1850 IF OLDCOL% = 3 THEN LOCATE 1,32: PRINT "YAW": GOTO 1900 ELSE
1860 IF OLDCOL% = 4 THEN LOCATE 1,41: PRINT "PITCH": GOTO 1900 ELSE
1870 IF OLDCOL% = 5 THEN LOCATE 1,53: PRINT "ROLL": GOTO 1900 ELSE
1880 IF OLDCOL% = 6 THEN LOCATE 1,62: PRINT "YAW M.": GOTO 1900 ELSE
1890 IF OLDCOL% = 7 THEN LOCATE 1,74: PRINT "AOA": GOTO 1900 ELSE
1900 COLOR 14,4
1910 IF COL% = 1 THEN LOCATE 1,9: PRINT "LIFT": GOTO 1980 ELSE
1920 IF COL% = 2 THEN LOCATE 1,20: PRINT "DRAG": GOTO 1980 ELSE
1930 IF COL% = 3 THEN LOCATE 1,32: PRINT "YAW": GOTO 1980 ELSE
1940 IF COL% = 4 THEN LOCATE 1,41: PRINT "PITCH": GOTO 1980 ELSE
1950 IF COL% = 5 THEN LOCATE 1,53: PRINT "ROLL": GOTO 1980 ELSE
1960 IF COL% = 6 THEN LOCATE 1,62: PRINT "YAW M.": GOTO 1980 ELSE
1970 IF COL% = 7 THEN LOCATE 1,74: PRINT "AOA": GOTO 1980 ELSE
1980 COLOR 15,1,7
1990 RETURN
2000 '-----CHECK COMMANDS-----
2010 I% = 0
2020 WHILE I% < 7 AND VALID% = 0
2030     I% = I% + 1
2040     IF REP2$ = COMMAND$(I%) THEN FLAG% = I%: VALID% = 1

```

Figure A.12 ADATA.BAS (cont.)

```

2050      WEND
2060      IF VALID% = 0 THEN GOSUB 2420  'ERROR MESSAGE
2070      RETURN
2080      '-----SCROLL DOWN-----
2090      FWD% = VAL(REP$): IF FWD% = 0 THEN FWD% = 1
2100      PAGE% = PAGE% + FWD%
2110      IF PAGE% < 1 THEN PAGE% = 1
2120      GOSUB 1050  'PRINT BACKGROUND LINES
2130      ROW% = 3: COL% = 1: GOSUB 1740: GOSUB 1900  'HIGHLIGHT
        FIRST ROW AND COLUMN
2140      GOSUB 1430  'PRINT COLUMNS 1-7 AND Q VALUE
2150      OLDXPOS% = 0
2160      RETURN
2170      '-----SCROLL UP-----
2180      FWD% = VAL(REP$): IF FWD% = 0 THEN FWD% = 1
2190      PAGE% = PAGE% - FWD%
2200      IF PAGE% < 1 THEN PAGE% = 1
2210      GOSUB 1050  'PRINT BACKGROUND LINES
2220      ROW% = 3: COL% = 1: GOSUB 1740: GOSUB 1900  'HIGHLIGHT
        FIRST ROW AND COLUMN
2230      GOSUB 1430  ' PRINT COLUMNS 1-7 AND Q VALUE
2240      OLDXPOS% = 0
2250      RETURN
2260      '-----PRINT OUT Q VALUE-----
2270      LOCATE 23,12: PRINT BLANK$
2280      LOCATE 23,12: INPUT "Q =";Q
2290      LOCATE 23,12: PRINT BLANK$
2300      COLOR 0,10
2310      LOCATE 22,7: PRINT USING "###";Q
2320      COLOR 15,1,7
2330      RETURN
2340      '-----EXIT EDITOR-----
2350      IF SAVED% = 1 OR MODIFIED% = 0 THEN GOTO 2410
2360      LOCATE 23,20: PRINT BLANK2$: BEEP
2370      LOCATE 23,20: INPUT "SAVE FILE (Y/N)";REP$
2380      IF REP$ = "N" OR REP$ = "n" THEN GOTO 2410
2390      GOSUB 2770  'SAVE FILE
2400      LOCATE 23,20: PRINT BLANK2$
2410      RETURN
2420      '-----ERROR MESSAGE-----
2430      LOCATE 23,20: PRINT BLANK2$
2440      LOCATE 23,20: PRINT " INVALID COMMAND"
2450      FOR F = 300 TO 500 STEP 100
2460          SOUND F,2
2470          SOUND 32767,2
2480      NEXT
2490      FOR I = 1 TO 500 STEP 1
2500      NEXT I
2510      LOCATE 23,20: PRINT BLANK2$
2520      RETURN

```

Figure A.12 ADATA.BAS (cont.)

```

2530 '-----ADD TEST POINTS TO FILE-----
2540 CLS
2550 LOCATE 3,5: PRINT"THIS OPTION ALLOWS YOU TO INCREASE
      THE NUMBER OF TEST"
2560 LOCATE 4,5: PRINT"POINTS OF AN EXISTING FILE"
2570 LOCATE 7,5: INPUT"WHAT IS THE NAME OF YOUR FILE";FILE$
2580 FILE$ = FD$ + FILE$
2590 GOSUB 2680
2610 LOCATE 10,5: INPUT"WHAT IS THE NEW NUMBER OF TUNNEL
      RUNS";NOQ%
2620 LOCATE 13,5: INPUT"WHAT IS THE NEW NUMBER OF TEST
      POINTS PER RUN";NOD%
2630 GOSUB 2770
2660 LOCATE 20,5: PRINT"NOW YOU CAN CALL UP YOUR FILE AND
      ADD IN THE NEW POINTS"
2670 RETURN
2680 '-----READ IN FILE-----
2690 OPEN FILE$ FOR INPUT AS #1
2700 INPUT #1,NOD%,CONFIG$,CONF
2710 INPUT #1,Q,W
2714 INPUT #1,ZL,ZD,ZY,ZPM,ZYM,ZRM,ZAOA
2715 INPUT #1,CLL,CALD,CALY,CALPM,CALYM,CALRM,CALAOA
2720   FOR J = 1 TO NOD%
2730     INPUT #1,LF(J),DF(J),YF(J),PM(J),RM(J),YM(J),AOA(J)
2740   NEXT J
2750 CLOSE #1
2760 RETURN
2770 '-----SAVE FILE-----
2780 LOCATE 23,20: PRINT BLANK2$: LOCATE 23,30: PRINT
      "SAVING FILE"
2790 OPEN FILE$ FOR OUTPUT AS #2
2800 WRITE #2,NOD%,CONFIG$,CONF
2810 WRITE #2,Q,W
2814 WRITE #2,ZL,ZD,ZY,ZPM,ZYM,ZRM,ZAOA
2815 WRITE #2,CLL,CALD,CALY,CALPM,CALYM,CALRM,CALAOA
2820   FOR J = 1 TO NOD%
2830     WRITE #2,LF(J),DF(J),YF(J),PM(J),RM(J),YM(J),AOA(J)
2840   NEXT J
2850 CLOSE #2
2860 RETURN

```

Figure A.12 ADATA.BAS (cont.)

```

10 REM----COMP.BAS;  CALCULATE Cd, Cl AND E. F. A.-----
15 REM
16 DIM LF(100),DF(100),YF(100),PM(100),YM(100),RM(100),
   AOA(100)
17 DIM CD(100),CL(100),EFA(100)
20 COLOR 15,1,4:KEY OFF:CLS
30 PRINT "WHAT IS THE NAME OF YOUR FILE CONTAINING THE";
35 PRINT " CALIBRATED"
40 INPUT "WIND TUNNEL DATA";FILE$
50 FILE$ = FD$+ FILE$
60 GOSUB 680 'READ IN DATA FROM FILE
70 REM -- FOR THE FOLLOWING, AREAL IS MEASURED IN SQUARE
   FEET
90 AREAL =60/144
270 FOR J = 1 TO NOD%
280     CL(J) = LF(J)/(Q*AREAL)
290     CD(J) = DF(J)/(Q*AREAL)
295     EFA(J) =LF(J)/Q
300     NEXT J
310 '-----STORE DATA FOR Cd VS. Cl-----
311 INPUT"WHAT IS THE NAME FOR THE FILE TO STORE Cd VS.
   Cl DATA";N$
312 Y$="Cd":X$="Cl"
320 OPEN FD$+N$ FOR OUTPUT AS #1
330 WRITE #1,NOD%,Y$,X$,CONFIG$,CONF
340 WRITE #1,Q
350     FOR J = 1 TO NOD%
360         WRITE #1,CD(J),CL(J)
370     NEXT J
380 CLOSE #1
390 '-----STORE DATA FOR Cd VS. Cl*Cl-----
391 INPUT"WHAT IS THE NAME FOR THE FILE TO STORE Cd VS.
   Cl^2 DATA";N$
392 Y$="Cd":X$="Cl^2"
400 OPEN FD$+N$ FOR OUTPUT AS #2
410 WRITE #2,NOD%,Y$,X$,CONFIG$,CONF
420 WRITE #2,Q
430     FOR J = 1 TO NOD%
440         B = CL(J)*CL(J)
450         WRITE #2,CD(J),B
460     NEXT J
470 CLOSE #2
480 '-----STORE DATA FOR Cl VS. AOA-----
481 INPUT"WHAT IS THE NAME FOR THE FILE TO STORE THE Cl
   VS. AOA DATA";N$
482 Y$="Cl":X$="AOA"
490 OPEN FD$+N$ FOR OUTPUT AS #2
500 WRITE #2,NOD%,Y$,X$,CONFIG$,CONF
510 WRITE #2,Q
520     FOR J = 1 TO NOD%

```

Figure A.13 COMP.BAS - Program to Calculate Parameters



```

530         WRITE #2,CL(J),AOA(J)
540     NEXT J
550 CLOSE #2
560 '-----STORE DATA FOR E.F.A. VS AOA-----
561 INPUT"WHAT IS THE NAME FOR THE FILE TO STORE THE
    .F.A. VS. AOA DATA";N$
562 Y$="E.F.A.":X$="AOA"
570 OPEN FD$+N$ FOR OUTPUT AS #1
580 WRITE #1,NOD%,Y$,X$,CONFIG$,CONF
590 WRITE #1,Q
600     FOR J = 1 TO NOD%
610         WRITE #1,EFA(J),AOA(J)
620     NEXT J
630 CLOSE #1
640 '-----RETURN TO MAIN PROGRAM-----
650 COMMON FD$,PD$,DX%
660 CHAIN PD$+"MAIN.BAS",2110
670 '-----READ IN DATA FROM CALIBRATED FILE-----
680 OPEN FILE$ FOR INPUT AS #2
690 INPUT #2,NOD%,CONFIG$,CONF
700 INPUT #2,Q,W
701 INPUT #2,ZL,ZD,ZY,ZPM,ZYM,ZRM,ZAOA
702 INPUT #2,CLL,CALD,CALY,CALPM,CALYM,CALRM,CALAOA
710     FOR J = 1 TO NOD%
720         INPUT #2,LF(J),DF(J),YF(J),PM(J),RM(J),YM(J),
            AOA(J)
730     NEXT J
740 CLOSE #2
750 RETURN

```

Figure A.13 COMP.BAS (cont.)



```

10  '-----DATA EDITOR-----
20  GOSUB 180
30  COLOR 15,1,7: KEY OFF: CLS
40  LOCATE 5,34: PRINT "*OPTIONS MENU*"
50  PRINT
60  PRINT
70  PRINT TAB(30) "1.  CREATE A NEW FILE"
80  PRINT
90  PRINT TAB(30) "2.  EDIT EXISTING FILE"
100 PRINT
110 PRINT TAB(30) "3.  INCREASE NUMBER OF TEST POINTS"
120 PRINT TAB(30) "    IN AN EXISTING FILE"
130 PRINT
140 PRINT TAB(30) "4.  EXIT DATA EDITOR"
150 LOCATE 20,5: INPUT "ENTER YOUR CHOICE (1,2,3,4)";REP%
160 ON REP% GOSUB 380,270,2200,490
170 GOTO 30
180 '-----INITIALIZING CONSTANTS-----
190 OPTION BASE 1: KEY OFF
200 DIM Y(100),X(100),COMMAND(10)
210 BLANK2$ = "                                " 1
220 BLANK1$ = "                                "
230 BLANK$ = "                                "
240 COMMAND$(1) = "c":COMMAND$(2) = "r": COMMAND$(3) = "d"
250 COMMAND$(4) = "e": COMMAND$(5) = "s": COMMAND$(6) =
    "u": COMMAND$(7) = "q"
260 RETURN
270 '-----EDIT A FILE-----
280 CLS: COLOR 15,1,7
290 LOCATE 5,10: INPUT "ENTER YOUR FILE NAME";FILES$
295 FILES$ = FD$ + FILES$
300 GOSUB 2350 ' READ IN FILE
310 PAGE% = 1: COL% = 1: SAVED% = 0: OLDXPOS% = 0:
    OLDYPOS% = 0
320 GOSUB 1010 'PRINT BACKGROUND LINES
330 ROW% = 3: GOSUB 1520 : GOSUB 1620 'HIGHLIGHT
    FIRST ROW AND COLUMN
340 LOCATE 23,30: PRINT "LISTING": BEEP
350 GOSUB 1360 'PRINT COLUMNS 1-7 AND Q VALUE
360 LOCATE 23,20: PRINT BLANK2$
370 GOTO 480
380 '-----CREATE A FILE-----
390 COLOR 15,1,7: CLS
400 LOCATE 5,10: INPUT "ENTER YOUR FILE NAME";FILES$
405 FILR$ = FD$ + FILES$
410 LOCATE 7,10: INPUT "ENTER TEST CONFIGURATION";CONFIG$
420 LOCATE 9,10: INPUT "ENTER THE NUMBER OF TEST POINTS
    PER RUN";NOD%
430 LOCATE 11,10: INPUT "ENTER TITLE FOR X-VALUES (i.e.
    CL, AOA)";X1$

```

Figure A.14 BDATA.BAS - On-Screen Data Editor

```

440 LOCATE 13,10: INPUT "ENTER TITLE FOR Y-VALUES (i.e.
    Cd, Cl)";Y1$
450 PAGE% = 1: COL% = 1: SAVED% = 0: OLDXPOS% = 0:
    OLDYPOS% = 0
460 GOSUB 1010 'PRINT BACKGROUND LINES
470 ROW% = 3: GOSUB 1520: GOSUB 1620 'HIGHLIGHT FIRST
    ROW AND COLUMN
480 GOSUB 500 ' INSERT NEW DATA
490 COMMON FD$, PD$,DX%
491 CHAIN PD$+"MAIN.BAS",2110
492 RETURN
500 '-----CHANGE OR INSERT DATA-----
510 LOCATE 23,12: PRINT BLANK$
520 LOCATE 23,12: INPUT REP$: IF REP$ = "" THEN GOTO 540
530 GOTO 580
540 LOCATE 23,12: PRINT BLANK$: LOCATE 23,12: PRINT
    "INVALID COMMAND": BEEP
550 FOR I = 1 TO 500 STEP 1
560 NEXT I
570 GOTO 510
580 REP2$ = RIGHT$(REP$,1)
590 T1% = ASC(REP2$)
600 IF T1% >= 43 AND T1% <= 57 THEN GOTO 660
610 T1% = T1% OR 32: REP2$ = CHR$(T1%)
620 GOSUB 1670
630 IF VALID% = 0 THEN GOTO 510 ELSE VALID% = 0
640 ON FLAG% GOSUB 1550,1450,1750,2010,2440,1840,1930
650 IF REP2$ <> "e" THEN GOTO 510 ELSE GOTO 1000
660 WHILE REP2$ <> "e"
670 NEWDATA = VAL(REP$)
680 IF QUIT% = 1 OR OLDXPOS% = 0 THEN QUIT% = 0: GOTO
    710 ELSE
690 LOCATE OLDXPOS%,OLDYPOS%,0
700 PRINT USING "####.##";OLDDATA
710 LOCATE 23,12: PRINT BLANK$
720 R% = ROW% - 2
730 IF COL% = 1 THEN Y(R%+18*(PAGE%-1))=NEWDATA: YPOS%
    = 18: GOTO 750: ELS
740 IF COL% = 2 THEN X(R%+18*(PAGE%-1))=NEWDATA: YPOS%
    = 43: GOTO 750: ELSE
750 XPOS% = ROW%
760 LOCATE XPOS%,YPOS%: COLOR 0,10
770 PRINT USING "####.##"; NEWDATA: MODIFIED% = 1
780 SAVED% = 0: COLOR 15,1
790 OLDYPOS% = YPOS%: OLDXPOS% = XPOS%: OLDDATA =
    NEWDATA
800 FWD% = 1
810 I% = ROW%+1: GOSUB 1470 'HIGHLIGHT NEW ROW
820 IF I% > NOD%+2 THEN FWD% = 1 ELSE FWD% = 0
830 IF I% > 20 THEN FWD% = 1 ELSE FWD% = 0

```

Figure A.14 BDATA.BAS (cont.)

```

840 GOSUB 1570 'HIGHLIGHT NEW ROW
850 COLOR 15,1,7
860 LOCATE 23,12: PRINT BLANK$
870 LOCATE 23,12: INPUT REP$: IF REP$ = "" THEN GOTO
890
880 GOTO 910
890 LOCATE 23,12: PRINT BLANK$: LOCATE 23,12: PRINT
"INVALID COMMAND": BEEP
900 GOTO 860
910 REP2$ = RIGHT$(REP$,1)
920 T1% = ASC(REP2$)
930 IF T1% >= 43 AND T1% <= 57 THEN GOTO 660
940 T1% = T1% OR 32: REP2$ = CHR$(T1%)
950 GOSUB 1670 'CHECK COMMANDS
960 IF VALID% = 0 THEN GOTO 510 ELSE VALID% = 0
970 ON FLAG% GOSUB 1550,1450,1750,2010,2440,1840,1930
'COMMAND SUBROUTINES
980 IF REP2$ <> "e" THEN GOTO 860 ELSE GOTO 990
990 WEND
1000 RETURN
1010 '-----PRINT BACKGROUND LINES-----
1020 COLOR 15,1,7
1030 CLS
1040 LOCATE 2,1
1050 FOR I% = 1 TO 80 : PRINT CHR$(220);: NEXT
1060 LOCATE 1,18: PRINT "Y = ";Y1$
1070 LOCATE 1,43: PRINT "X = ";X1$
1080 LOCATE 1,68: PRINT "COMMANDS"
1090 LOCATE 21,1
1100 FOR I% = 1 TO 80 : PRINT CHR$(220);: NEXT
1110 FOR I% = 1 TO 22
1120 LOCATE I%,1: PRINT CHR$(222)
1130 LOCATE I%,80: PRINT CHR$(222)
1140 NEXT
1150 FOR I% = 1 TO 21
1160 LOCATE I%,28: PRINT CHR$(179)
1170 LOCATE I%,53: PRINT CHR$(179)
1180 NEXT
1190 FOR I% = 1 TO 18
1200 LOCATE I%+2,2
1210 PRINT USING "###";I%+18*(PAGE%-1);: PRINT ":"
1220 NEXT
1230 COLOR 15,4
1240 LOCATE 3,66: PRINT "C COLUMN"
1250 LOCATE 4,66: PRINT "R ROW"
1260 LOCATE 5,66: PRINT "D DOWN"
1270 LOCATE 6,66: PRINT "E EXIT"
1280 LOCATE 7,66: PRINT "S SAVE"
1290 LOCATE 8,66: PRINT "U UP"
1300 LOCATE 9,66: PRINT "Q TUNNEL SPEED"

```

Figure A.14 BDATA.BAS (cont.)

```

1310 COLOR 14,0: LOCATE 23,44: PRINT CONFIG$
1320 COLOR 15,1,7
1330 LOCATE 22,2: PRINT "[Q =": LOCATE 22,12: PRINT "]"
1340 LOCATE 23,3: PRINT "COMMAND :"
1350 RETURN
1360 '-----PRINT COLUMNS 1-7 AND Q VALUE-----
1370 FOR I% = 1 TO 18
1380     LOCATE I%+2,18: PRINT USING "####.##";Y(I%+18*(PAGE%
        E%-1))
1390     NEXT
1400 FOR I% = 1 TO 18
1410     LOCATE I%+2,43: PRINT USING "####.##";X(I%+18*(PAGE
        E%-1))
1420     NEXT
1430 LOCATE 22,7:PRINT USING "###";Q
1440 RETURN
1450 '-----ROW INDEXING-----
1460 FWD% = VAL(REP$): IF FWD% = 0 THEN FWD% = 1
1470 OLDROW% = ROW%: ROW% = ROW% + FWD%
1480 IF ROW% > NOD%+2 THEN ROW% = 3
1490 IF ROW% > 20 THEN ROW% = 3
1500 IF ROW% < 3 THEN ROW% = 3
1510 LOCATE OLDROW%,2: PRINT USING "###";OLDROW%-2+18*(PAGE
        E%-1);: PRINT ":"
1520 COLOR 14,4: LOCATE ROW%,2: PRINT USING "###";ROW%-2+1
        8*(PAGE%-1);:PRINT ":"
1530 COLOR 15,1,7
1540 RETURN
1550 '-----COLUMN INDEXING-----
1560 FWD% = VAL(REP$): IF FWD% = 0 THEN FWD% = 1
1570 OLDCOL% = COL%: COL% = COL% + FWD%
1580 IF COL% > 2 THEN COL% = 1
1590 IF COL% < 1 THEN COL% = 2
1600 IF OLDCOL% = 1 THEN LOCATE 1,18: PRINT "Y = ";Y1$:
        GOTO 1620 ELSE
1610 IF OLDCOL% = 2 THEN LOCATE 1,43: PRINT "X = ";X1$:
        GOTO 1620 ELSE
1620 COLOR 14,4
1630 IF COL% = 1 THEN LOCATE 1,18: PRINT "Y = ";Y1$: GOTO
        1650 ELSE
1640 IF COL% = 2 THEN LOCATE 1,43: PRINT "X = ";X1$: GOTO
        1650 ELSE
1650 COLOR 15,1,7
1660 RETURN
1670 '-----CHECK COMMANDS-----
1680 I% = 0
1690 WHILE I% < 7 AND VALID% = 0
1700     I% = I% + 1
1710     IF REP2$ = COMMAND$(I%) THEN FLAG% = I%: VALID% = 1
1720     WEND

```

Figure A.14 BDATA.BAS (cont.)



```

1730     IF VALID% = 0 THEN GOSUB 2090 'ERROR MESSAGE
1740 RETURN
1750 '-----SCROLL DOWN-----
1760 FWD% = VAL(REP$): IF FWD% = 0 THEN FWD% = 1
1770 PAGE% = PAGE% + FWD%
1780 IF PAGE% < 1 THEN PAGE% = 1
1790 GOSUB 1010 'PRINT BACKGROUND LINES
1800 ROW% = 3: COL% = 1: GOSUB 1520: GOSUB 1620 'HIGHLIGHT
    FIRST ROW AND COLUMN
1810 GOSUB 1360 'PRINT COLUMNS 1-7 AND Q VALUE
1820 OLDXPOS% = 0
1830 RETURN
1840 '-----SCROLL UP-----
1850 FWD% = VAL(REP$): IF FWD% = 0 THEN FWD% = 1
1860 PAGE% = PAGE% - FWD%
1870 IF PAGE% < 1 THEN PAGE% = 1
1880 GOSUB 1010 'PRINT BACKGROUND LINES
1890 ROW% = 3: COL% = 1: GOSUB 1520: GOSUB 1620 'HIGHLIGHT
    FIRST ROW AND COLUMN
1900 GOSUB 1360 ' PRINT COLUMNS 1-7 AND Q VALUE
1910 OLDXPOS% = 0
1920 RETURN
1930 '-----PRINT OUT Q VALUE-----
1940 LOCATE 23,12: PRINT BLANK$
1950 LOCATE 23,12: INPUT "Q =";Q
1960 LOCATE 23,12: PRINT BLANK$
1970 COLOR 0,10
1980 LOCATE 22,7: PRINT USING "###";Q
1990 COLOR 15,1,7
2000 RETURN
2010 '-----EXIT EDITOR-----
2020 IF SAVED% = 1 OR MODIFIED% = 0 THEN GOTO 2080
2030 LOCATE 23,20: PRINT BLANK2$: BEEP
2040 LOCATE 23,20: INPUT "SAVE FILE (Y/N)";REP$
2050 IF REP$ = "N" OR REP$ = "n" THEN GOTO 2080
2060 GOSUB 2440 'SAVE FILE
2070 LOCATE 23,20: PRINT BLANK2$
2080 RETURN
2090 '-----ERROR MESSAGE-----
2100 LOCATE 23,20: PRINT BLANK2$
2110 LOCATE 23,20: PRINT " INVALID COMMAND"
2120 FOR F = 300 TO 500 STEP 100
2130     SOUND F,2
2140     SOUND 32767,2
2150     NEXT
2160 FOR I = 1 TO 500 STEP 1
2170     NEXT I
2180 LOCATE 23,20: PRINT BLANK2$
2190 RETURN
2200 '-----ADD TEST POINTS TO FILE-----

```

Figure A.14 BDATA.BAS (cont.)



```

2210 CLS
2220 LOCATE 3,5: PRINT"THIS OPTION ALLOWS YOU TO INCREASE
      THE NUMBER OF TEST"
2230 LOCATE 4,5: PRINT"POINTS OF AN EXISTING FILE"
2240 LOCATE 7,5: INPUT"WHAT IS THE NAME OF YOUR FILE";FILE$
2250 FILE$ = FD$ + FILE$
2260 GOSUB 2350
2290 LOCATE 13,5: INPUT"WHAT IS THE NEW NUMBER OF TEST
      POINTS PER RUN";NOD%
2300 GOSUB 2440
2330 LOCATE 20,5: PRINT"NOW YOU CAN CALL UP YOUR FILE AND
      ADD IN THE NEW POINTS"
2340 RETURN
2350 '-----READ IN FILE-----
2360 OPEN FILE$ FOR INPUT AS #1
2370 INPUT #1,NOD%,Y1$,X1$,CONFIG$,CONF
2380 INPUT #1,Q
2390     FOR J = 1 TO NOD%
2400         INPUT #1,Y(J),X(J)
2410     NEXT J
2420 CLOSE #1
2430 RETURN
2440 '-----SAVE FILE-----
2450 LOCATE 23,20: PRINT BLANK2$: LOCATE 23,30: PRINT
      "SAVING FILE"
2460 OPEN FILE$ FOR OUTPUT AS #2
2470 WRITE #2,NOD%,Y1$,X1$,CONFIG$,CONF
2480 WRITE #2,Q
2490     FOR J = 1 TO NOD%
2500         WRITE #2,Y(J),X(J)
2510     NEXT J
2520 CLOSE #2
2530 RETURN

```

Figure A.14 BDATA.BAS (cont.)

```

10  '-----PLOTTING ROUTINE-----
20  DIM X(300),Y(300),B(300),C(300),D(300)
30  KEY OFF: SCREEN 2
40  HDPOS% = 44: B$ = "
60  GOSUB 260
70  OPT$ = CURVE$(1)
80  ERASE X,Y,FILESTK$,CURVE$,B,C,D
90  CHAIN PD$+"MAIN.BAS",2110,ALL
150 '-----READ IN FILE-----
160 OPEN FILE$ FOR INPUT AS #2
170 INPUT #2,NOD%,Y1$,X1$,H$,CONF
180 INPUT #2,Q
190 FOR I% = 1 TO NOD%
200     INPUT #2,Y(I%),X(I%)
210     NEXT
220 CLOSE #2
230 RETURN
260 '-----INITIALIZING PLOTTER-----
270 FOR L% = 1 TO NOF%
280     FILE$ = FILESTK$(L%)
290     GOSUB 160
300     IF L%=1 THEN XMIN=X(1): XMAX=XMIN: YMIN=Y(1):
YMAX=YMIN
310     FOR I%=1 TO NOD%
320         IF X(I%)<XMIN THEN XMIN=X(I%) ELSE IF X(I%)>
XMAX THEN XMAX=X(I%)
330         IF Y(I%)<YMIN THEN YMIN=Y(I%) ELSE IF Y(I%)>
YMAX THEN YMAX=Y(I%)
340     NEXT I%
350 NEXT L%
351 CLS
352 PRINT "AFTER CURVES ARE PLOTTED YOU HAVE THE OPTION
OF OBTAINING A HARD"
353 PRINT "COPY BY PRESSING CTRL-PRTSC.  THE CURVE WILL
REMAIN ON THE SCREEN"
354 PRINT "UNTIL YOU PRESS THE F2 KEY."
355 PRINT
360 INPUT "HEADDING FOR PLOT =";HEAD$
370 T1%=LEN(HEAD$): IF T1%>60 THEN HEAD$=LEFT$(HEAD$,60)
380 INPUT "X TITLE FOR THE PLOT =";XTITLE$
390 T1%=LEN(XTITLE$): IF T1%>60 THEN XTITLE$=LEFT$(XTITLE
$,60)
400 INPUT "Y TITLE FOR THE PLOT =";YTITLE$
410 T1%=LEN(YTITLE$): IF T1%>60 THEN YTITLE$=LEFT$(YTITLE
$,60)
420 PRINT "MINIMUM X VALUE = [DEFAULT: ";XMIN;"]": INPUT
T1$
430 IF T1$ <> "" THEN TEMP=VAL(T1$) ELSE TEMP=XMIN
440 IF TEMP<=XMIN THEN OK%=1 ELSE OK%=0
450 IF T1$ <> "" THEN TEMP3 =XMIN: XMIN = TEMP

```

Figure A.15 PLOTTER.BAS - Screen Graphics Program

```

460 PRINT "MAXIMUM X VALUE = [DEFAULT: "; XMAX; "]" ;: INPUT
    T1$
470 IF T1$ <> "" THEN XMAX=VAL(T1$)
480 PRINT "MINIMUM Y VALUE = [DEFAULT: "; YMIN; "]" ;: INPUT
    T1$
490 IF T1$ <> "" THEN YMIN=VAL(T1$)
500 PRINT "MAXIMUM Y VALUE = [DEFAULT: "; YMAX; "]" ;: INPUT
    T1$
510 IF T1$ <> "" THEN YMAX=VAL(T1$)
520 RANGE=XMAX-XMIN
530 IF OK%=1 THEN PTR%=1: STKPTR%=1: PGSTK%(1)=1 ELSE
    GOSUB 580
540 CLS: SCREEN 2
550 GOSUB 840
560 RETURN
570 '-----SET PAGES-----
580 TEMP2=(TEMP-TEMP3)/RANGE+1: PG%=INT(TEMP2)
590 STKPTR%=PG%+1
600 FOR I% = 1 TO STKPTR%
610     T2=TEMP-RANGE*(I%-1)
620     J%=1
630     WHILE X(J%)<T2
640         J%=J%+1
650     WEND
660     PGSTK%(PG%-I%+2)=J%
670 NEXT I%
680 PTR%=PGSTK%(STKPTR%)
690 RETURN
700 '-----PLOT WITHOUT GRID-----
710 LINE(ORIGINX%,ORIGINY%)-(ORIGINX%+7*INTERVALX%,TEMP4%
    ),1,B
720 X%=ORIGINX%
730 FOR I% = 1 TO 8
740     LINE (X%,162)-(X%,165)
750     X%=X%+INTERVALX%
760 NEXT
770 T1%=ORIGINX%-8: T2%=ORIGINY%
780 FOR I% = 1 TO 5
790     LINE (T1%,T2%)-(ORIGINX%,T2%)
800     T2%=T2%+INTERVALY%
810 NEXT
820 RETURN
830 '-----PLOTING ROUTINES-----
840 ORIGINY%=12: ORIGINX%=72: INTERVALY%=30: INTERVALX%=80
850 TEMP4%=ORIGINY%+5*INTERVALY%
870 VIEW(0,0)-(639,163): CLS: VIEW
890 GOSUB 710
900 IF LEFT$(GRD$,1)="G" THEN GOSUB 2400
910 X%=ORIGINX%: Y%=ORIGINY%
920 FOR L%=1 TO NOF%

```

Figure A.15 PLOTTER.BAS (cont.)

```

930      IF NOF%=1 THEN GOTO 960
940      FILE$=FILESTK$(L%)
950      GOSUB 160
960      XINDEX=XMIN
970      GOSUB 1410
980      IF L%=1 THEN GOSUB 1120
990      IF L% <> NOF% THEN PTR%=PGSTK%(STKPTR%)
1000     NEXT L%
1001     ON KEY(1) GOSUB 1006
1002     ON KEY(2) GOSUB 1009
1003     KEY(2) OFF: KEY(1) ON: KEY(2) ON
1004     IF FLAG = 1 THEN GOTO 1100
1005     GOTO 1001
1006     LOCATE 23,1: PRINT "HI"
1008     RETURN
1009     FLAG = 1
1010     RETURN
1100     FLAG = 0
1101     RETURN
1110     '-----PLOT ZERO LINE-----
1120     IF (YMAX*YMIN < 0) THEN TEMP=(-1*YMIN/(YMAX-YMIN))*150
        ELSE GOTO 1150
1130     DELTAY%=CINT(TEMP)
1140     LINE(ORIGINX%,TEMP4%-DELTAY%)-(ORIGINX%+7*INTERVALX%,
        TEMP4%-DELTAY%)
1150     IF (XMAX*XMIN < 0) THEN TEMP=(-1*XMIN/(XMAX-XMIN))*550
        ELSE GOTO 1190
1160     DELTAX%=CINT(TEMP)
1170     LINE(ORIGINX%+DELTAX%,ORIGINY%)-(ORIGINX%+DELTAX%,TEM
        P4%)
1180     '-----PRINT INDECIES-----
1190     YINDEX=YMAX
1200     TEMP = (YMAX-YMIN)/5
1210     P%=LEN(HEAD$): P%=HDPOS%-(P%*.5)
1220     LOCATE 1,1: PRINT TAB(P%) HEAD$
1230     FOR I% = 1 TO 6
1240         PRINT USING "###.###";YINDEX
1250         IF (I%= 3) THEN FOR J% = 1 TO 2: PRINT: NEXT J%:
        GOTO 1260
1255         IF (I%<>6) THEN FOR J% = 1 TO 3: PRINT: NEXT J%
1260         YINDEX=YINDEX-TEMP
1270         NEXT I%
1280     XINDEX = XMIN: XINCR=(XMAX-XMIN)/7
1285     LOCATE 22,1
1290     PRINT USING "#####.##";XINDEX;
1300     FOR I% = 1 TO 7
1310         XINDEX = XINDEX + XINCR
1320         PRINT USING "#####.##";XINDEX; : NEXT I%
1330     P%=LEN(XTITLE$): P%=HDPOS%-(P%*.5)
1340     LOCATE 23,1: PRINT TAB(P%) XTITLE$

```

Figure A.15 PLOTTER.BAS (cont.)



```

1350 T1%=LEN(YTITLE$): P%=11-(T1%*.5)
1360 FOR I% = 1 TO T1%
1370     T1$=MID$(YTITLE$,I%,1): LOCATE P%+I%,1: PRINT T1$
1380     NEXT
1395 RETURN
1400 '-----PLOT POINTS ON GRAPH-----
1410 TEMP2=1/(YMAX-YMIN): TEMP3=1/(XMAX-XMIN)
1420 IF MRK$="" THEN MRK$="MARK    "
1430 REP2$=LEFT$(MRK$,1)
1440 T%=L%: REP$=LEFT$(CURVE$(L%),1)
1450 IF T%>3 THEN T%=T%-3 : GOTO 1450
1460 IF REP$="C" THEN GOSUB 1870
1470 COUNT%=0: NDP%=0
1480 WHILE (PTR%<=NOD%) AND (X(PTR%) <= XMAX)
1490     IF X(PTR%) < XMIN THEN GOTO 1650
1500     OLDY%=Y%: OLDX%=X%
1510     NDP% = NDP%+1
1520     TEMP1=ABS((X(PTR%)-XMIN)*TEMP3)*550
1530     TEMP=ABS((Y(PTR%)-YMIN)*TEMP2)*150
1540     DELTAY%=CINT(TEMP): DELTAX%=CINT(TEMP1)
1560     Y%=TEMP4%-DELTAY% : X%=ORIGINX%+DELTAX%
1570     IF COUNT%=0 THEN OLDY%=Y%: OLDX%=X%: PSET(X%,Y%):
        FIRSTX%=X%: FIRSTY%=Y%: COUNT%=1
1580     IF REP$="P" THEN 1600
1590     LINE-(X%,Y%),1
1600     IF REP2$ <> "M" AND REP <> "P" THEN GOTO 1630
1610     IF T%=1 THEN CIRCLE(X%,Y%),2,1,0,6.28,5/12
1611     IF T%=2 THEN LINE(X%,Y%)-(X%+6,Y%): LINE-(X%+3,Y%
        -3): LINE-(X%,Y%)
1612     ELSE LINE(X%,Y%)-(X%+6,Y%-3),1,B : PSET(X%,Y%)
1620     GOTO 1640
1630     PSET(X%,Y%)
1640     IF REP$="C" THEN GOSUB 2140
1650     PTR%=PTR%+1
1660     WEND
1720 RETURN
1860 '-----CUBIC INTERPOLATION-----
1870 DIM H(200),A(200),L(200),U(200),Z(200)
1880 FOR I% = 1 TO NOD%-1
1890     H(I%)=X(I%+1)-X(I%)
1900     NEXT
1910 FOR I%=2 TO NOD%-1
1920     T1=Y(I%+1)*H(I%-1)
1930     T2=Y(I%)*(X(I%+1)-X(I%-1))
1940     T3=Y(I%-1)*H(I%)
1950     A(I%)=3*(T1-T2+T3)/(H(I%-1)*H(I%))
1960     NEXT I%
1970 L(1)=1: U(1)=0: Z(1)=0
1980 FOR I%=2 TO NOD%
1990     L(I%)=2*(X(I%+1)-X(I%-1))-H(I%-1)*U(I%-1)

```

Figure A.15 PLOTTER.BAS (cont.)

```

2000      U(I%)=H(I%)/L(I%)
2010      Z(I%)=(A(I%)-H(I%-1)*Z(I%-1))/L(I%)
2020      NEXT I%
2030      L(NOD%)=1: Z(NOD%)=0: C(NOD%)=0
2040      FOR J%=NOD%-1 TO 1 STEP -1
2050          C(J%)=Z(J%)-U(J%)*C(J%+1)
2060          T1=(Y(J%+1)-Y(J%))/H(J%)
2070          T2=H(J%)*(C(J%+1)+2*C(J%))/3
2080          B(J%)=T1-T2
2090          D(J%)=(C(J%+1)-C(J%))/(3*H(J%))
2100      NEXT J%
2110      ERASE H,A,L,U,Z
2120      RETURN
2130      '-----PLOT CUBIC-----
2140      IF PTR%+1 > NOD% OR X(PTR%+1) > XMAX THEN GOTO 2280
2150      T1=(XMAX-XMIN)/560 : T2=X(PTR%)
2160      TEMP1=ABS((X(PTR%+1)-XMIN)*TEMP3)*550
2170      DELTAX%=CINT(TEMP1)
2180      XNEXT%=ORIGINX%+DELTAX%
2190      X%=X%+2
2200      IF X% >= XNEXT% THEN GOTO 2280
2210      T2=T2 + 2*T1
2220      T4=T2-X(PTR%)
2230      T3=Y(PTR%)+B(PTR%)*T4+C(PTR%)*T4*T4+D(PTR%)*T4*T4*T4
2240      TEMP=ABS((T3-YMIN)*TEMP2)*150
2250      DELTAY%=CINT(TEMP): Y%=TEMP4%-DELTAY%
2260      IF Y%>172 THEN Y%=172 ELSE IF Y%<12 THEN Y%=12
2270      LINE-(X%,Y%) : GOTO 2190
2280      RETURN
2400      '-----PLOT WITH GRIDS-----
2410      FOR I% = 1 TO 9
2420          T1%=ORIGINY%+I%*15
2430          LINE(73,T1%)-(623,T1%),,,&H4444
2440      NEXT I%
2450      FOR I%= 1 TO 13
2460          T1%=ORIGINX%+I%*40
2470          LINE(T1%,12)-(T1%,162),,,&HAAAA
2480      NEXT I%
2490      RETURN
2500      END

```

Figure A.15 PLOTTER.BAS (cont.)

```

10 'NAME:  Data Acquisition And Control (DAAC)
20 '      HEADER for BASICA
30 '
40 'FILE NAME:  DACHDR.BAS
50 '
60 'DOS DEVICE NAME:  DAAC
70 '
80 'RESERVED FUNCTION NAMES:
90 '      AINM, AINS, AINSC, AOUM, AOUS,
100 '      BINM, BINS, BITINS, BITOUS, BOUM, BOUS,
110 '      CINM, CINS, CSET, DELAY
120 'RESERVED DEF SEG VALUE NAME:  DSEG
130 '
140 'NAMES DEFINED AND USED BY HEADER:
150 '      ADAPT%, AI, COUNT, FOUND%,
160 '      HNAME$, SG%, STAT%
170 '
180 '
190 'When using the BASICA Interpreter, this header
200 'must be executed before any function calls are
210 'made that access the DAAC adapter.  It initializes
220 'a number of variables for each function call.  These
230 'variables are reserved and should not be used except
240 'to access the DAAC adapter.  This routine also does a
250 'DEF SEG to the segment where the DAAC Device Driver
260 '(DAC.COM) is loaded.  If you execute a DEF SEG to
270 'access other hardware, you must DEF SEG to the segment
280 'of the DAAC Device Driver before any subsequent
290 'calls to access the DAAC adapter.
300 '
310 '
320 FOUND% = 0
330 SG% = &H2E
340 'Start searching the interrupt vectors until you find
350 'one that points to the DAAC device driver.
360 'Do a DEF SEG to that segment.
370 WHILE ((SG% <= &H3E) AND (FOUND% = 0))
380     DEF SEG = 0
390     DSEG = PEEK(SG%) + PEEK(SG% + 1) * 256
400     DEF SEG = DSEG
410     HNAME$=""
420     FOR AI=10 TO 17
430         HNAME$ = HNAME$ + CHR$(PEEK(AI))
440     NEXT AI
450     IF HNAME$ = "DAAC" AND PEEK(18) + PEEK(19) <>
       0 THEN FOUND% = 1
460     SG% = SG% + 4
470 WEND
480 IF FOUND% = 0 THEN PRINT "ERROR: DEVICE DRIVER DAC.COM
    NOT FOUND" : END

```

Figure A.16 BALCAL.BAS - Balance Calibration Program

```

490 'Now initialize all function name variables for calls
500 'to access the device driver.
510 AINM      = PEEK(&H13) * 256 + PEEK(&H12)
520 AINS      = PEEK(&H15) * 256 + PEEK(&H14)
530 AINSC     = PEEK(&H17) * 256 + PEEK(&H16)
540 AOUM      = PEEK(&H19) * 256 + PEEK(&H18)
550 AOUS      = PEEK(&H1B) * 256 + PEEK(&H1A)
560 BINM      = PEEK(&H1D) * 256 + PEEK(&H1C)
570 BINS      = PEEK(&H1F) * 256 + PEEK(&H1E)
580 BITINS    = PEEK(&H21) * 256 + PEEK(&H20)
590 BITOUS    = PEEK(&H23) * 256 + PEEK(&H22)
600 BOUM      = PEEK(&H25) * 256 + PEEK(&H24)
610 BOUS      = PEEK(&H27) * 256 + PEEK(&H26)
620 CINM      = PEEK(&H29) * 256 + PEEK(&H28)
630 CINS      = PEEK(&H2B) * 256 + PEEK(&H2A)
640 CSET      = PEEK(&H2D) * 256 + PEEK(&H2C)
650 DELAY     = PEEK(&H2F) * 256 + PEEK(&H2E)
660 'Finally, execute any call to re-initialize the
670 'device driver from any former invocation of BASIC.
680 ADAPT% = 0
690 COUNT = 1
700 STAT% = 0
710 CALL DELAY (ADAPT%, COUNT, STAT%)
720 '
730 'End of DAAC BASICA Header
740 '
750 REM-----BALCAL.BAS  (CALIBRATE BALANCE)-----
760 REM
765 DIM L(100),D(100),Y(100),PM(100),YM(100),RM(100),LBS(
    100)
769 DIM DAT(399),DAT%(399),DAT1(399),DAT1%(399)
770 FOR I = 1 TO 12
780     IF I = 1 THEN FILE$ = "LIFTP"
790     IF I = 2 THEN FILE$ = "DRAGP"
800     IF I = 3 THEN FILE$ = "YAWP"
810     IF I = 4 THEN FILE$ = "PITCHMP"
820     IF I = 5 THEN FILE$ = "YAWMP"
830     IF I = 6 THEN FILE$ = "ROLLMP"
840     IF I = 7 THEN FILE$ = "LIFTN"
850     IF I = 8 THEN FILE$ = "DRAGN"
860     IF I = 9 THEN FILE$ = "YAWN"
870     IF I = 10 THEN FILE$ = "PITCHMN"
880     IF I = 11 THEN FILE$ = "YAWMN"
890     IF I = 12 THEN FILE$ = "ROLLMN"
900 REM
910 REM
920 GOSUB 1380 'RECORD CALIBRATION DATA
930 NEXT I
940 CLS
950 LOCATE 10,5:PRINT "CALCULATING CALIBRATION CONSTANTS,"

```

Figure A.16 BALCAL.BAS (cont.)



```

PLEASE WAIT"
960 GOSUB 2100 'CALCULATE K1&K2 FOR ALL PRIME GAGES
970 GOSUB 2640 'CONVERT COUNTS TO FORCES
980 GOSUB 3180 'CALCULATE INTERACTION CONSTANTS
990 REM
1000 REM STORE CALIBRATION CONSTANTS
1010 OPEN "C:CONST" FOR OUTPUT AS #1
1020 WRITE #1,INCALL,INCALD,INCALY,INCALPM,INCALYM,INCALRM
1040 WRITE #1,K1LPOS,K2LPOS,K1DPOS,K2DPOS,K1YPOS,K2YPOS
1050 WRITE #1,K1PMPOS,K2PMPOS,K1YMPOS,K2YMPOS,K1RMPOS,
K2RMPOS
1060 WRITE #1,K1LNEG,K2LNEG,K1DNEG,K2DNEG,K1YNEG,K2YNEG
1070 WRITE #1,K1PMNEG,K2PMNEG,K1YMNEG,K2YMNEG,K1RMNEG,
K2RMNEG
1080 WRITE #1,DDDL1P,DDDL2P,DYDL1P,DYDL2P,DPMDL1P,DPMDL2P
,DYMDL1P,DYMDL2P
1090 WRITE #1,DRMDL1P,DRMDL2P
1100 WRITE #1,DLDD1P,DLDD2P,DYDD1P,DYDD2P,DPMDD1P,DPMDD2P
,DYMDD1P,DYMDD2P
1110 WRITE #1,DRMDD1P,DRMDD2P
1120 WRITE #1,DLDY1P,DLDY2P,DDDY1P,DDDY2P,DPMDY1P,DPMDY2P
,DYMDY1P,DYMDY2P
1130 WRITE #1,DRMDY1P,DRMDY2P
1140 WRITE #1,DLDPM1P,DLDPM2P,DDDPM1P,DDDPM2P,DYDPM1P,DYD
PM2P,DYMDPM1P,DYMDPM2P
1150 WRITE #1,DRMDPM1P,DRMDPM2P
1160 WRITE #1,DLDYM1P,DLDYM2P,DDDYM1P,DDDYM2P,DYDYM1P,DYD
YM2P,DPMDYM1P,DPMDYM2P
1170 WRITE #1,DRMDYM1P,DRMDYM2P
1180 WRITE #1,DLDRM1P,DLDRM2P,DDDRM1P,DDDRM2P,DYDRM1P,DYD
RM2P,DPMDRM1P,DPMDRM2P
1190 WRITE #1,DYMDRM1P,DYMDRM2P
1200 WRITE #1,DDDL1N,DDDL2N,DYDL1N,DYDL2N,DPMDL1N,DPMDL2N
,DYMDL1N,DYMDL2N
1210 WRITE #1,DRMDL1N,DRMDL2N
1220 WRITE #1,DLDD1N,DLDD2N,DYDD1N,DYDD2N,DPMDD1N,DPMDD2N
,DYMDD1N,DYMDD2N
1230 WRITE #1,DRMDD1N,DRMDD2N
1240 WRITE #1,DLDY1N,DLDY2N,DDDY1N,DDDY2N,DPMDY1N,DPMDY2N
,DYMDY1N,DYMDY2N
1250 WRITE #1,DRMDY1N,DRMDY2N
1260 WRITE #1,DLDPM1N,DLDPM2N,DDDPM1N,DDDPM2N,DYDPM1N,DYD
PM2N,DYMDPM1N
1270 WRITE #1,DYMDPM2N,DRMDPM1N,DRMDPM2N
1280 WRITE #1,DLDYM1N,DLDYM2N,DDDYM1N,DDDYM2N,DYDYM1N,DYD
YM2N,DPMDYM1N
1290 WRITE #1,DPMDYM2N,DRMDYM1N,DRMDYM2N
1300 WRITE #1,DLDRM1N,DLDRM2N,DDDRM1N,DDDRM2N,DYDRM1N,DYD
RM2N,DPMDRM1N
1310 WRITE #1,DPMDRM2N,DYMDRM1N,DYMDRM2N

```

Figure A.16 BALCAL.BAS (cont.)

```

1320 CLOSE #1
1330 CLS: LOCATE 10,5
1340 PRINT " CALIBRATION COMPLETE"
1350 END
1360 REM
1370 REM
1380 REM---RECORD CALIBRATION DATA-----
1401 COLOR 15,1: KEY OFF: CLS
1402 PRINT "CALIBRATION FOR THE LOADING OF THE ";FILE$;"
      COMPONENT"
1403 PRINT: INPUT "AFTER ALL AMPLIFIERS ARE ZEROED PRESS
      RETURN";X
1404 CLS
1405 PRINT "      ZD          ZL          ZY          ZPM          ZYM
      ZRM "
1406 STAT%=0:  MODE%=0:  STOR%=0:  COUNT=100:  RATE=500
1407 ADAPT%= 0:  DEVICE%= 9:  CHANLO%= 0:  CTRL%= 0:  CHANHI%=3
1408 CALL AINSC(ADAPT%,DEVICE%,CHANLO%,CHANHI%,CTRL%,MODE%
      ,STOR%,COUNT,RATE,DAT%(0),STAT%)
1409 ZD = 0:ZPM=0:ZL=0:ZYM=0
1410 IF STAT%<> 0 THEN PRINT USING "EXECUTION ERROR ###";
      STAT%:END
1411 FOR J = 0 TO 396 STEP 4
1412 DAT(J)=(DAT%(J)/204.8)-10
1413 ZD =ZD + DAT(J)
1414 NEXT J
1415 ZD = ZD/100
1416 FOR J = 1 TO 397 STEP 4
1417 DAT(J)=(DAT%(J)/204.8)-10
1418 ZL = ZL + DAT(J)
1419 NEXT J
1420 FOR J = 2 TO 398 STEP 4
1421 DAT(J)=(DAT%(J)/204.8)-10
1422 ZPM = ZPM + DAT(J)
1423 NEXT J
1424 FOR J = 3 TO 399 STEP 4
1425 DAT(J)=(DAT%(J)/204.8)-10
1426 ZYM = ZYM + DAT(J)
1427 NEXT J
1428 STAT%=0:  MODE%=0:  STOR%=0:  COUNT=100:  RATE=500
1429 ADAPT%= 1:  DEVICE%= 9:  CHANLO%= 0:  CTRL%= 0:  CHANHI%=1
1430 CALL AINSC(ADAPT%,DEVICE%,CHANLO%,CHANHI%,CTRL%,MODE%
      ,STOR%,COUNT,RATE,DAT1%(0),STAT%)
1431 ZY =0:ZRM=0
1432 IF STAT%<> 0 THEN PRINT USING "EXECUTION ERROR ###";
      STAT%:END
1435 FOR J = 0 TO 198 STEP 2
1436 DAT1(J)=(DAT1%(J)/204.8)-10
1437 ZRM = ZRM + DAT1(J)
1438 NEXT J

```

Figure A.16 BALCAL.BAS (cont.)

```

1439 ZRM = ZRM/100
1440 FOR J = 1 TO 199 STEP 2
1441 DAT1(J)=(DAT1%(J)/204.8)-10
1442 ZY = ZY + DAT1(J)
1443 NEXT J
1444 ZL=ZL/100:ZPM=ZPM/100:ZYM=ZYM/100:ZY=ZY/100
1445 LOCATE 3,1: PRINT USING "+#.###";ZD: LOCATE 3,10: PRI
    NT USING "+#.###";ZL
1446 LOCATE 3,19: PRINT USING "+#.###";ZY
1447 LOCATE 3,28: PRINT USING "+#.###";ZPM
1448 LOCATE 3,37: PRINT USING "+#.###";ZYM
1449 LOCATE 3,46: PRINT USING "+#.###";ZRM
1451 REM
1452 PRINT:PRINT
1453 INPUT "AFTER PLACING ALL CAL SWITCHES TO + SETTING HIT
    RETURN";X
1454 PRINT
1455 PRINT " CALD      CLL      CALY      CALPM      CALYM
    CALRM"
1456 STAT%=0: MODE%=0: STOR%=0: COUNT=100: RATE=500
1457 ADAPT%= 0: DEVICE%= 9: CHANLO%= 0: CTRL%= 0: CHANHI%=3
1458 CALL AINSC(ADAPT%,DEVICE%,CHANLO%,CHANHI%,CTRL%,MODE%
    ,STOR%,COUNT,RATE,DAT%(0),STAT%)
1459 CALD=0:CLL=0:CALYM=0:CALPM=0
1460 IF STAT%<> 0,THEN PRINT USING "EXECUTION ERROR ###";
    STAT%:END
1461 FOR J = 0 TO 396 STEP 4
1462 DAT(J)=(DAT%(J)/204.8)-10
1463 CALD =CALD + DAT(J)
1464 NEXT J
1465 CALD = CALD/100
1466 FOR J = 1 TO 397 STEP 4
1467 DAT(J)=(DAT%(J)/204.8)-10
1468 CLL = CLL + DAT(J)
1469 NEXT J
1470 FOR J = 2 TO 398 STEP 4
1471 DAT(J)=(DAT%(J)/204.8)-10
1472 CALPM = CALPM + DAT(J)
1473 NEXT J
1474 FOR J = 3 TO 399 STEP 4
1475 DAT(J)=(DAT%(J)/204.8)-10
1476 CALYM = CALYM + DAT(J)
1477 NEXT J
1478 STAT%=0: MODE%=0: STOR%=0: COUNT=100: RATE=500
1479 ADAPT%= 1: DEVICE%= 9: CHANLO%= 0: CTRL%= 0: CHANHI%=1
1480 CALL AINSC(ADAPT%,DEVICE%,CHANLO%,CHANHI%,CTRL%,MODE%
    ,STOR%,COUNT,RATE,DAT1%(0),STAT%)
1481 CALY =0:CALRM=0
1482 IF STAT%<> 0 THEN PRINT USING "EXECUTION ERROR ###";
    STAT%:END

```

Figure A.16 BALCAL.BAS (cont.)

```

1485 FOR J = 0 TO 198 STEP 2
1486 DAT1(J)=(DAT1%(J)/204.8)-10
1487 CALRM = CALRM + DAT1(J)
1488 NEXT J
1489 CALRM = CALRM/100
1490 FOR J = 1 TO 199 STEP 2
1491 DAT1(J)=(DAT1%(J)/204.8)-10
1492 CALY = CALY + DAT1(J)
1493 NEXT J
1494 CLL=CLL/100:CALPM=CALPM/100:CALYM=CALYM/100:CALY=CALY
/100
1495 LOCATE 10,1: PRINT USING "+#.###";CALD
1496 LOCATE 10,10: PRINT USING "+#.###";CLL
1497 LOCATE 10,19: PRINT USING "+#.###";CALY
1498 LOCATE 10,28: PRINT USING "+#.###";CALPM
1499 LOCATE 10,37: PRINT USING "+#.###";CALYM
1500 LOCATE 10,46: PRINT USING "+#.###";CALRM
1501 REM
1502 REM
1503     IF I = 1 THEN INCALL = CLL - ZL
1510     IF I = 2 THEN INCALD = CALD - ZD
1520     IF I = 3 THEN INCALY = CALT - ZY
1530     IF I = 4 THEN INCALPM = CALPM - ZPM
1540     IF I = 5 THEN INCALYM = CALYM - ZYM
1550     IF I = 6 THEN INCALRM = CALRM - ZRM
1611 PRINT:INPUT "PRESS ENTER (RETURN) TO CONTINUE";X
1620 CLS:PRINT "RETURN ALL CAL SWITCHES TO CENTER POSITION"
1630 PRINT:
1640 PRINT "LOAD THE ";FILE$;" GAGE FROM 0 TO 20 POUNDS AND
THEN BACK TO 0"
1650 PRINT "POUNDS IN 1 POUND INCREMENTS.  THERE SHOULD BE
TWO READINGS FOR"
1660 PRINT "EACH POUND WEIGHT EXCEPT FOR THE LOAD AT 20
POUNDS WHICH WILL HAVE"
1670 PRINT "ONLY ONE READING"
1680 PRINT
1690 PRINT "PRESS THE F1 KEY WHEN THE LOADING IS FINISHED"
1700 PRINT "PRESS THE F2 KEY WHEN READY TO RECORD THE DATA
FOR THAT LOAD"
1701 PRINT: INPUT "PRESS ENTER (RETURN) TO CONTINUE";X
1702 CLS
1703 PRINT "  DRAG          LIFT          YAW          PITCH          YAW
ROLL  "
1704 PRINT "                                MOM.          MOM.
MOM.  "
1710 SOAP = 0: N=4
1720 FOR K = 1 TO 100
1730 ON KEY(1) GOSUB 1830      'SET STOP FLAG
1740 ON KEY(2) GOSUB 1841      'RECORD DATA
1750 KEY(1) ON: KEY(2) ON

```

Figure A.16 BALCAL.BAS (cont.)



```

1760 IF SOAP = 2 THEN GOTO 1780
1770 IF SOAP = 1 THEN GOTO 1920
1775 GOTO 1730
1780 SOAP = 0
1790 NOD% = K
1800 NEXT K
1810 GOTO 1920
1830 REM SET STOP FLAG
1838 SOAP = 1
1839 RETURN
1840 REM STEPS TO RECORD DATA
1841 STAT%=0: MODE%=0: STOR%=0: COUNT=100: RATE=500
1842 ADAPT%= 0: DEVICE%= 9: CHANLO%= 0: CTRL%= 0: CHANHI%=3
1843 CALL AINSC(ADAPT%,DEVICE%,CHANLO%,CHANHI%,CTRL%,MODE%
,STOR%,COUNT,RATE,DAT%(0),STAT%)
1844 D(K)=0:L(K)=0:YM(K)=0:PM(K)=0
1845 IF STAT%<> 0,THEN PRINT USING "EXECUTION ERROR ###";
STAT%:END
1846 FOR J = 0 TO 396 STEP 4
1847 DAT(J)=(DAT%(J)/204.8)-10
1848 D(K) =D(K) + DAT(J)
1849 NEXT J
1850 D(K) = D(K)/100
1851 FOR J = 1 TO 397 STEP 4
1852 DAT(J)=(DAT%(J)/204.8)-10
1853 L(K) = L(K) + DAT(J)
1854 NEXT J
1855 FOR J = 2 TO 398 STEP 4
1856 DAT(J)=(DAT%(J)/204.8)-10
1857 PM(K) = PM(K) + DAT(J)
1858 NEXT J
1859 FOR J = 3 TO 399 STEP 4
1860 DAT(J)=(DAT%(J)/204.8)-10
1861 YM(K) = YM(K) + DAT(J)
1862 NEXT J
1863 STAT%=0: MODE%=0: STOR%=0: COUNT=100: RATE=500
1864 ADAPT%= 1: DEVICE%= 9: CHANLO%= 0: CTRL%= 0: CHANHI%=1
1865 CALL AINSC(ADAPT%,DEVICE%,CHANLO%,CHANHI%,CTRL%,MODE%
,STOR%,COUNT,RATE,DAT1%(0),STAT%)
1866 Y(K) =0:RM(K)=0
1867 IF STAT%<> 0 THEN PRINT USING "EXECUTION ERROR ###";
STAT%:END
1868 FOR J = 0 TO 198 STEP 2
1869 DAT1(J)=(DAT1%(J)/204.8)-10
1870 RM(K) = RM(K) + DAT1(J)
1871 NEXT J
1872 RM(K) = RM(K)/100
1873 FOR J = 1 TO 199 STEP 2
1874 DAT1(J)=(DAT1%(J)/204.8)-10
1875 Y(K) = Y(K) + DAT1(J)

```

Figure A.16 BALCAL.BAS (cont.)

```

1876 NEXT J
1877 L(K)=L(K)/100:PM(K)=PM(K)/100:YM(K)=YM(K)/100:Y(K)=Y(
K)/100
1878 IF N> 23 THEN N=4:CLS:PRINT " DRAG          LIFT          YAW
      PITCH          YAW          ROLL ":PRINT "
      MOM.          MOM.          MOM. "
1879 LOCATE N,1: PRINT USING "+#.###";D(K)
1880 LOCATE N,10: PRINT USING "+#.###";L(K)
1881 LOCATE N,19: PRINT USING "+#.###";Y(K)
1882 LOCATE N,28: PRINT USING "+#.###";PM(K)
1883 LOCATE N,37: PRINT USING "+#.###";YM(K)
1884 LOCATE N,46: PRINT USING "+#.###";RM(K)
1885 N=N+1
1900 SOAP = 2
1910 RETURN 'GO BACK FOR NEXT DATA POINT
1920 '---CORRECT FOR DRIFT-----
1921 DIFFL=(L(NOD%)-L(1)): DIFFD=(D(NOD%)-D(1)):DIFFY=(Y(
NOD%)-Y(1))
1922 DIFFPM=(PM(NOD%)-PM(1)):DIFFYM=(YM(NOD%)-YM(1)):DIFFR
M=(RM(NOD%)-RM(1))
1923 D=NOD%-1
1924 CORL=DIFFL/D:CORD=DIFFD/D:CORY=DIFFY/D:CORPM=DIFFPM/D
      :CORYM=DIFFYM/D:CORRM=DIFFRM/D
1925 A=1
1926 FOR K = 2 TO NOD%
1927 L(K)=L(K)-(A*CORL)
1928 D(K)=D(K)-(A*CORD)
1929 Y(K)=Y(K)-(A*CORY)
1930 PM(K)=PM(K)-(A*CORPM)
1931 YM(K)=YM(K)-(A*CORYM)
1932 RM(K)=RM(K)-(A*CORRM)
1933 A = A+1
1934 NEXT K
1935 '---WRITE DATA TO FILE-----
1940 FILE$ = "C:"+FILE$
1950 OPEN FILE$ FOR OUTPUT AS #1
1960 WRITE #1,ZL,ZD,ZY,ZPM,ZYM,ZRM,NOD%
1970 WRITE #1,CLL,CALD,CALY,CALPM,CALYM,CALRM
1971 IF I=1 OR I=2 OR I=3 THEN GOTO 2079
1972 IF I=7 OR I=8 OR I=9 THEN GOTO 2067
1976 LBS = 0
1977 FOR J = 1 TO 11
1978 IF I=4 OR I=10 THEN D1=20
1979 IF I=5 OR I=11 THEN D1=4.5
1980 IF I=6 OR I=12 THEN D1=11.5
1981 MOM = LBS*D1 'CONVERT TO MOMENTS
1982 IF I=10 OR I=11 OR I=12 THEN MOM=MOM*(-1)
1983 WRITE #1,L(J),D(J),Y(J),PM(J),YM(J),RM(J),MOM
1984 LBS = LBS+1
1985 NEXT J

```

Figure A.16 BALCAL.BAS (cont.)

```

1986 LBS = 9
1987 FOR J = 12 TO NOD%
1988     IF I=4 OR I=10 THEN D1=20
1989     IF I=5 OR I=11 THEN D1=4.5
1990     IF I=6 OR I=12 THEN D1=11.5
1991     MOM = LBS*D1 'CONVERT TO MOMENTS
1992     IF I=10 OR I=11 OR I=12 THEN MOM=MOM*(-1)
1993     WRITE #1,L(J),D(J),Y(J),PM(J),YM(J),RM(J),MOM
1994     LBS = LBS-1
1995     NEXT J
1996 CLOSE #1
1997 RETURN      'GO BACK TO SET UP NEXT CALIBRATION
2067 LBS = 0
2068 FOR J = 1 TO 21
2069     WRITE #1,L(J),D(J),Y(J),PM(J),YM(J),RM(J),LBS
2070     LBS = LBS - 1
2071     NEXT J
2072 LBS = -19
2073 FOR J = 22 TO NOD%
2074     WRITE #1,L(J),D(J),Y(J),PM(J),YM(J),RM(J),LBS
2075     LBS = LBS + 1
2076     NEXT J
2077 CLOSE #1
2078 RETURN      'GO BACK TO SET UP NEXT CALIBRATION
2079 LBS = 0
2080 FOR J = 1 TO 21
2081     WRITE #1,L(J),D(J),Y(J),PM(J),YM(J),RM(J),LBS
2082     LBS = LBS + 1
2083     NEXT J
2084 LBS = 19
2085 FOR J = 22 TO NOD%
2086     WRITE #1,L(J),D(J),Y(J),PM(J),YM(J),RM(J),LBS
2087     LBS = LBS - 1
2088     NEXT J
2089 CLOSE #1
2090 RETURN      'GO BACK TO SET UP NEXT CALIBRATION
2100 REM-----
2110 REM CALCULATE K1&K2 FOR PRIME GAGES
2120 FOR I = 1 TO 12
2130     IF I = 1 THEN FILE$ = "LIFTP"
2140     IF I = 2 THEN FILE$ = "DRAGP"
2150     IF I = 3 THEN FILE$ = "YAWP"
2160     IF I = 4 THEN FILE$ = "PITCHMP"
2170     IF I = 5 THEN FILE$ = "YAWMP"
2180     IF I = 6 THEN FILE$ = "ROLLMP"
2190     IF I = 7 THEN FILE$ = "LIFTN"
2200     IF I = 8 THEN FILE$ = "DRAGN"
2210     IF I = 9 THEN FILE$ = "YAWN"
2220     IF I = 10 THEN FILE$ = "PITCHMN"
2230     IF I = 11 THEN FILE$ = "YAWMN"

```

Figure A.16 BALCAL.BAS (cont.)

```

2240     IF I = 12 THEN FILE$ = "ROLLMN"
2250 GOSUB 2295     'READ FILES AND PERFORM CALCULATIONS
2260 NEXT I
2270 RETURN     'GO BACK TO CONVERT COUNTS
2280 REM
2290 REM
2295 A=0:B=0:C=0:D=0:E=0:
2300 OPEN "C:"+FILE$ FOR INPUT AS #2
2310 INPUT #2,ZL,ZD,ZY,ZPM,ZYM,ZRM,NOD%
2320 INPUT #2,CLL,CALD,CALY,CALPM,CALYM,CALRM
2340 FOR J = 1 TO NOD%
2350     INPUT #2,L(J),D(J),Y(J),PM(J),YM(J),RM(J),LBS(J)
2360         IF I = 1 OR I = 7 THEN X = L(J)
2370         IF I = 2 OR I = 8 THEN X = D(J)
2380         IF I = 3 OR I = 9 THEN X = Y(J)
2390         IF I = 4 OR I = 10 THEN X = PM(J)
2400         IF I = 5 OR I = 11 THEN X = YM(J)
2410         IF I = 6 OR I = 12 THEN X = RM(J)
2420     A = A + (X^2)
2430     B = B + (X^3)
2440     C = C + (X^4)
2450     D = D + (X*LBS(J))
2460     E = E + (X*X*LBS(J))
2470 NEXT J
2480 CLOSE #2
2490 K2 = ((D/A)-(E/B))/((B/A)-(C/B))
2500 K1 = (D/A) - (K2*(B/A))
2510 IF I = 1 THEN K1LPOS = K1: K2LPOS = K2
2520 IF I = 2 THEN K1DPOS = K1: K2DPOS = K2
2530 IF I = 3 THEN K1YPOS = K1: K2YPOS = K2
2540 IF I = 4 THEN K1PMPOS = K1: K2PMPOS = K2
2550 IF I = 5 THEN K1YMPOS = K1: K2YMPOS = K2
2560 IF I = 6 THEN K1RMPOS = K1: K2RMPOS = K2
2570 IF I = 7 THEN K1LNEG = K1: K2LNEG = K2
2580 IF I = 8 THEN K1DNEG = K1: K2DNEG = K2
2590 IF I = 9 THEN K1YNEG = K1: K2YNEG = K2
2600 IF I = 10 THEN K1PMNEG = K1: K2PMNEG = K2
2610 IF I = 11 THEN K1YMNEG = K1: K2YMNEG = K2
2620 IF I = 12 THEN K1RMNEG = K1: K2RMNEG = K2
2630 RETURN     'GO BACK TO CALCULATE K1&K2 FOR NEXT FILE
2640 REM-----
2650 REM CONVERT COUNTS TO FORCES
2660 FOR I = 1 TO 12
2670     IF I = 1 THEN FILE$ = "LIFTP"
2680     IF I = 2 THEN FILE$ = "DRAGP"
2690     IF I = 3 THEN FILE$ = "YAWP"
2700     IF I = 4 THEN FILE$ = "PITCHMP"
2710     IF I = 5 THEN FILE$ = "YAWMP"
2720     IF I = 6 THEN FILE$ = "ROLLMP"
2730     IF I = 7 THEN FILE$ = "LIFTN"

```

Figure A.16 BALCAL.BAS (cont.)



```

2740     IF I = 8 THEN FILE$ = "DRAGN"
2750     IF I = 9 THEN FILE$ = "YAWN"
2760     IF I = 10 THEN FILE$ = "PITCHMN"
2770     IF I = 11 THEN FILE$ = "YAWMN"
2780     IF I = 12 THEN FILE$ = "ROLLMN"
2790 GOSUB 2835 'READ IN FILE AND CONVERT
2800 NEXT I
2810 RETURN 'GO BACK TO CALCULATE INTERACTON CONSTANTS
2820 REM
2830 REM
2835 A=0:B=0:C=0:D=0:E=0:F=0
2840 OPEN "C:"+FILE$ FOR INPUT AS #2
2850 INPUT #2,ZL,ZD,ZY,ZPM,ZYM,ZRM,NOD%
2860 INPUT #2,CLL,CALD,CALY,CALPM,CALYM,CALRM
2870 FOR J = 1 TO NOD%
2880     INPUT #2,L(J),D(J),Y(J),PM(J),YM(J),RM(J),LBS(J)
2890     A=((INCALL/CLL-ZL)*(L(J)-ZL))
2900     B=((INCALD/CALD-ZD)*(D(J)-ZD))
2910     C=((INCALY/CALY-ZY)*(Y(J)-ZY))
2920     D=((INCALPM/CALPM-ZPM)*(PM(J)-ZPM))
2930     E=((INCALYM/CALYM-ZYM)*(YM(J)-ZYM))
2940     F=((INCALRM/CALRM-ZRM)*(RM(J)-ZRM))
2950     IF L(J) < 0 THEN K1 = K1LNEG: K2 = K2LNEG ELSE K1
        = K1LPOS:K2 = K2LPOS
2960     L(J)=(K1*A) + (K2*(A^2))
2970     IF D(J) < 0 THEN K1 = K1DNEG: K2 = K2DNEG ELSE K1
        = K1DPOS:K2 = K2DPOS
2980     D(J)=(K1*B) + (K2*(B^2))
2990     IF Y(J) < 0 THEN K1 = K1YNEG: K2 = K2YNEG ELSE K1
        = K1YPOS:K2 = K2YPOS
3000     Y(J)=(K1*C) + (K2*(C^2))
3010     IF PM(J) < 0 THEN K1=K1PMNEG:K2=K2PMNEG ELSE K1=K1
        PMPOS:K2=K2PMPOS
3020     PM(J)=(K1*D) + (K2*(D^2))
3030     IF YM(J) < 0 THEN K1=K1YMNEG:K2=K2YMNEG ELSE K1=K1
        YMPOS:K2=K2YMPOS
3040     YM(J)=(K1*E) + (K2*(E^2))
3050     IF RM(J) < 0 THEN K1=K1RMNEG:K2=K2RMNEG ELSE K1=K1
        RMPOS:K2=K2RMPOS
3060     RM(J)=(K1*F) + (K2*(F^2))
3070 NEXT J
3080 CLOSE #2
3090 REM SAVE CONVERTED COUNTS
3100 OPEN "B:"+FILE$ FOR OUTPUT AS #1
3110 WRITE #1,ZL,ZD,ZY,ZPM,ZYM,ZRM,NOD%
3120 WRITE #1,CLL,CALD,CALY,CALPM,CALYM,CALRM
3130 FOR J = 1 TO NOD%
3140     WRITE #1,L(J),D(J),Y(J),PM(J),YM(J),RM(J),LBS(J)
3150 NEXT J
3155 CLOSE #1

```

Figure A.16 BALCAL.BAS (cont.)

```

3160 RETURN      'GO BACK TO CALCULATE INTERACTION CONSTANTS
3170 REM-----
3180 REM CALCULATE INTERACTION CONSTANTS
3190 FOR I = 1 TO 12
3200     IF I = 1 THEN FILE$ = "LIFTP"
3210     IF I = 2 THEN FILE$ = "DRAGP"
3220     IF I = 3 THEN FILE$ = "YAWP"
3230     IF I = 4 THEN FILE$ = "PITCHMP"
3240     IF I = 5 THEN FILE$ = "YAWMP"
3250     IF I = 6 THEN FILE$ = "ROLLMP"
3260     IF I = 7 THEN FILE$ = "LIFTN"
3270     IF I = 8 THEN FILE$ = "DRAGN"
3280     IF I = 9 THEN FILE$ = "YAWN"
3290     IF I = 10 THEN FILE$ = "PITCHMN"
3300     IF I = 11 THEN FILE$ = "YAWMN"
3310     IF I = 12 THEN FILE$ = "ROLLMN"
3320 GOSUB 3365 'READ IN FILES AND CALCULATE CONSTANTS
3330 NEXT I
3340 RETURN      'GO BACK TO SAVE CALIBRATION DATA
3350 REM
3360 REM
3365 A=0:B=0:C=0:D1=0:D2=0:D3=0:D4=0:D5=0:E1=0:E2=0:E3=0:E
4=0:E5=0
3370 OPEN "B:"+FILE$ FOR INPUT AS #2
3380 INPUT #2,ZL,ZD,ZY,ZPM,ZYM,ZRM,NOD%
3390 INPUT #2,CLL,CALD,CALY,CALPM,CALYM,CALRM
3410 FOR J = 1 TO NOD%
3420     INPUT #2,L(J),D(J),Y(J),PM(J),YM(J),RM(J),LBS(J)
3430     IF I=1 OR I=7 THEN X=L(J):Y1=D(J):Y2=Y(J):Y3=PM(J)
:Y4=YM(J):Y5=RM(J)
3440     IF I=2 OR I=8 THEN X=D(J):Y1=L(J):Y2=Y(J):Y3=PM(J)
:Y4=YM(J):Y5=RM(J)
3450     IF I=3 OR I=9 THEN X=Y(J):Y1=L(J):Y2=D(J):Y3=PM(J)
:Y4=YM(J):Y5=RM(J)
3460     IF I=4 OR I=10 THEN X=PM(J):Y1=L(J):Y2=D(J):Y3=Y(J)
:Y4=YM(J):Y5=RM(J)
3470     IF I=5 OR I=11 THEN X=YM(J):Y1=L(J):Y2=D(J):Y3=Y(J)
:Y4=PM(J):Y5=RM(J)
3480     IF I=6 OR I=12 THEN X=RM(J):Y1=L(J):Y2=D(J):Y3=Y(J)
:Y4=PM(J):Y5=YM(J)
3490     A = A + (X^2)
3500     B = B + (X^3)
3510     C = C + (X^4)
3520     D1 = D1 + (X*Y1)
3530     E1 = E1 + ((X^2)*Y1)
3540     D2 = D2 + (X*Y2)
3550     E2 = E2 + ((X^2)*Y2)
3560     D3 = D3 + (X*Y3)
3570     E3 = E3 + ((X^2)*Y3)
3580     D4 = D4 + (X*Y4)

```

Figure A.16 BALCAL.BAS (cont.)

```

3590      E4 = E4 + ((X^2)*Y4)
3600      D5 = D5 + (X*Y5)
3610      E5 = E5 + ((X^2)*Y5)
3620      NEXT J
3630 CLOSE #2
3640 K12 = ((D1/A)-(E1/B))/((B/A)-(C/B))
3650 K11 = (D1/A)-(K12*(B/A))
3660 K22 = ((D2/A)-(E2/B))/((B/A)-(C/B))
3670 K21 = (D2/A)-(K22*(B/A))
3680 K32 = ((D3/A)-(E3/B))/((B/A)-(C/B))
3690 K31 = (D3/A)-(K32*(B/A))
3700 K42 = ((D4/A)-(E4/B))/((B/A)-(C/B))
3710 K41 = (D4/A)-(K42*(B/A))
3720 K52 = ((D5/A)-(E5/B))/((B/A)-(C/B))
3730 K51 = (D5/A)-(K52*(B/A))
3740 IF I=1 THEN DDDL1P=K11:DDDL2P=K12:DYDL1P=K21:DYDL2P=K
22:DPMDL1P=K31
3750 IF I=1 THEN DPMDL2P=K32:DYMDL1P=K41:DYMDL2P=K42:DRMDL
1P=K51:DRMDL2P=K52
3760 IF I=2 THEN DLDD1P=K11:DLDD2P=K12:DYDD1P=K21:DYDD2P=K
22:DPMDD1P=K31
3770 IF I=2 THEN DPMDD2P=K32:DYMDD1P=K41:DYMDD2P=K42:DRMDD
1P=K51:DRMDD2P=K52
3780 IF I=3 THEN DLDY1P=K11:DLDY2P=K12:DDDY1P=K21:DDDY2P=K
22:DPMDY1P=K31
3790 IF I=3 THEN DPMDY2P=K32:DYMDY1P=K41:DYMDY2P=K42:DRMDY
1P=K51:DRMDY2P=K52
3800 IF I=4 THEN DLDP1P=K11:DLDP2P=K12:DDDP1P=K21:DDDP
2P=K22:DYDPM1P=K31
3810 IF I=4 THEN DYDPM2P=K32:DYMDPM1P=K41:DYMDPM2P=K42:DRM
DPM1P=K51:DRMDPM2P=K52
3820 IF I=5 THEN DLDYM1P=K11:DLDYM2P=K12:DDDYM1P=K21:DDDY
2P=K22:DYDYM1P=K31
3830 IF I=5 THEN DYDYM2P=K32:DPMDYM1P=K41:DPMDYM2P=K42:DRM
DYM1P=K51:DRMDYM2P=K52
3840 IF I=6 THEN DLDRM1P=K11:DLDRM2P=K12:DDDRM1P=K21:DDDR
2P=K22:DYDRM1P=K31
3850 IF I=6 THEN DYDRM2P=K32:DPMDRM1P=K41:DPMDRM2P=K42:DYM
DRM1P=K51:DYMDRM2P=K52
3860 IF I=7 THEN DDDL1N=K11:DDDL2N=K12:DYDL1N=K21:DYDL2N=K
22:DPMDL1N=K31
3870 IF I=7 THEN DPMDL2N=K32:DYMDL1N=K41:DYMDL2N=K42:DRMDL
1N=K51:DRMDL2N=K52
3880 IF I=8 THEN DLDD1N=K11:DLDD2N=K12:DYDD1N=K21:DYDD2N=K
22:DPMDD1N=K31
3890 IF I=8 THEN DPMDD2N=K32:DYMDD1N=K41:DYMDD2N=K42:DRMDD
1N=K51:DRMDD2N=K52
3900 IF I=9 THEN DLDY1N=K11:DLDY2N=K12:DDDY1N=K21:DDDY2N=K
22:DPMDY1N=K31
3910 IF I=9 THEN DPMDY2N=K32:DYMDY1N=K41:DYMDY2N=K42:DRMDY

```

Figure A.16 BALCAL.BAS (cont.)

```

1N=K51:DRMDY2N=K52
3920 IF I=10 THEN DLDP1N=K11:DLDP2N=K12:DDDP1N=K21:DDDP
M2N=K22:DYDP1N=K31
3930 IF I=10 THEN DYDP2N=K32:DYMDP1N=K41:DYMDP2N=K42:DR
MDP1N=K51
3940 IF I=10 THEN DRMDP2N=K52
3950 IF I=11 THEN DLDY1N=K11:DLDY2N=K12:DDDY1N=K21:DDDY
M2N=K22:DYDY1N=K31
3960 IF I=11 THEN DYDY2N=K32:DPMDY1N=K41:DPMDY2N=K42:DR
MDY1N=K51
3970 IF I=11 THEN DRMDY2N=K52
3980 IF I=12 THEN DLDR1N=K11:DLDR2N=K12:DDDR1N=K21:DDDR
M2N=K22:DYDR1N=K31
3990 IF I=12 THEN DYDR2N=K32:DPMDR1N=K41:DPMDR2N=K42:DY
MDR1N=K51
4000 IF I=12 THEN DYMDR2N=K52
4010 RETURN 'GOBACK TO SAVE CALIBRATION DATA

```

Figure A.16 BALCAL.BAS (cont.)



## APPENDIX B

### TABLES

#### INITIAL SET-UP FOR THE MODEL 8255 TRANSDUCER AMPLIFIER

| Amp. # | Component | Gain Set. | Filter Set. | Ex. Volt. |
|--------|-----------|-----------|-------------|-----------|
| 1      | DRAG      | MAX VAR.  | 1           | +5.0      |
| 2      | LIFT      | MAX VAR.  | 1           | +6.5      |
| 3      | PITCH M.  | 1K        | 1           | +5.0      |
| 4      | YAW M.    | MAX VAR.  | 1           | +5.0      |
| 5      | ROLL M.   | MAX VAR.  | 1           | +5.0      |
| 6      | YAW       | MAX VAR.  | 1           | +5.0      |
| 7      | AOA       | 1K        | 1           | +5.0      |

Table B.1 Amplifier Set-Up

| L<br>LBS. | D<br>LBS. | Y<br>LBS. | PM<br>IN.-LBS. | YM<br>IN.-LBS. | RM<br>IN.-LBS. | LOADS<br>LBS. |
|-----------|-----------|-----------|----------------|----------------|----------------|---------------|
| -0.071    | 0.113     | -0.007    | -0.011         | 0.004          | 0.186          | 0.000         |
| 0.280     | -1.387    | 0.045     | 0.378          | 0.287          | 14.516         | 1.000         |
| 1.585     | -2.601    | 0.049     | 0.891          | 0.625          | 29.482         | 2.000         |
| 1.664     | -4.074    | 0.105     | 1.435          | 0.912          | 43.893         | 3.000         |
| 2.848     | -5.052    | 0.127     | 1.874          | 1.278          | 59.583         | 4.000         |
| 4.271     | -6.129    | 0.153     | 2.713          | 1.607          | 73.570         | 5.000         |
| 5.375     | -7.449    | 0.242     | 3.158          | 1.854          | 88.797         | 6.000         |
| 6.020     | -8.869    | 0.158     | 3.596          | 2.217          | 104.396        | 7.000         |
| 7.221     | -10.076   | 0.192     | 4.368          | 2.589          | 119.488        | 8.000         |
| 7.526     | -11.329   | 0.248     | 4.782          | 2.963          | 135.242        | 9.000         |
| 8.937     | -12.496   | 0.242     | 5.261          | 3.110          | 152.621        | 10.000        |
| 9.933     | -14.106   | 0.351     | 5.818          | 3.441          | 167.287        | 11.000        |
| 10.405    | -15.140   | 0.399     | 6.286          | 3.812          | 183.977        | 12.000        |
| 12.029    | -16.199   | 0.316     | 6.754          | 4.125          | 200.527        | 13.000        |
| 12.926    | -17.125   | 0.479     | 7.583          | 4.458          | 216.548        | 14.000        |
| 12.718    | -18.477   | 0.494     | 8.123          | 4.798          | 233.051        | 15.000        |
| 15.056    | -19.601   | 0.468     | 8.699          | 5.111          | 250.094        | 16.000        |
| 16.137    | -21.004   | 0.544     | 9.320          | 5.411          | 266.391        | 17.000        |
| 17.027    | -22.130   | 0.520     | 9.872          | 5.768          | 283.582        | 18.000        |
| 18.145    | -23.641   | 0.669     | 10.391         | 6.097          | 300.855        | 19.000        |
| 19.308    | -24.989   | 0.553     | 11.033         | 6.387          | 316.969        | 20.000        |
| 18.069    | -23.486   | 0.586     | 10.611         | 6.064          | 301.018        | 19.000        |
| 17.189    | -22.140   | 0.536     | 9.914          | 5.795          | 284.159        | 18.000        |
| 16.028    | -20.774   | 0.476     | 9.537          | 5.440          | 266.569        | 17.000        |
| 15.428    | -19.346   | 0.429     | 8.877          | 5.157          | 250.179        | 16.000        |
| 13.816    | -18.680   | 0.487     | 8.168          | 4.785          | 233.317        | 15.000        |
| 13.337    | -17.414   | 0.519     | 7.745          | 4.570          | 216.317        | 14.000        |
| 12.021    | -16.133   | 0.396     | 6.991          | 4.098          | 200.854        | 13.000        |
| 11.244    | -15.067   | 0.369     | 6.782          | 3.864          | 184.612        | 12.000        |

Table B.2 Loading for Positive Lift

| L<br>LBS. | D<br>LBS. | Y<br>LBS. | PM<br>IN.-LBS. | YM<br>IN.-LBS. | RM<br>IN.-LBS. | LOADS<br>LBS. |
|-----------|-----------|-----------|----------------|----------------|----------------|---------------|
| 10.546    | -13.455   | 0.356     | 5.974          | 3.451          | 167.852        | 11.000        |
| 8.900     | -12.083   | 0.312     | 5.521          | 3.111          | 152.598        | 10.000        |
| 8.123     | -10.766   | 0.337     | 5.090          | 2.977          | 135.368        | 9.000         |
| 7.659     | -9.671    | 0.215     | 4.526          | 2.539          | 119.388        | 8.000         |
| 6.445     | -8.578    | 0.218     | 3.930          | 2.258          | 104.478        | 7.000         |
| 5.031     | -7.069    | 0.201     | 3.468          | 1.940          | 89.744         | 6.000         |
| 4.466     | -5.886    | 0.155     | 3.104          | 1.681          | 73.372         | 5.000         |
| 3.732     | -4.496    | 0.153     | 2.234          | 1.331          | 60.023         | 4.000         |
| 2.653     | -3.641    | 0.095     | 1.762          | 1.008          | 44.615         | 3.000         |
| 1.772     | -2.358    | 0.083     | 1.434          | 0.664          | 29.709         | 2.000         |
| 0.562     | -1.266    | 0.044     | 0.676          | 0.299          | 14.989         | 1.000         |
| -0.071    | 0.113     | -0.007    | -0.011         | 0.004          | 0.186          | 0.000         |

Table B.2 (cont.)

| L       | D      | Y      | PM       | YM       | RM       | LOADS   |
|---------|--------|--------|----------|----------|----------|---------|
| LBS.    | LBS.   | LBS.   | IN.-LBS. | IN.-LBS. | IN.-LBS. | LBS.    |
| -0.320  | 0.100  | -0.017 | 0.045    | -0.035   | 0.706    | 0.000   |
| -1.327  | 1.268  | -0.048 | -0.971   | -0.378   | -16.872  | -1.000  |
| -1.621  | 3.330  | -0.067 | -1.733   | -0.870   | -34.542  | -2.000  |
| -2.710  | 4.523  | -0.084 | -2.269   | -1.220   | -51.716  | -3.000  |
| -3.527  | 6.070  | -0.101 | -3.274   | -1.508   | -68.610  | -4.000  |
| -4.738  | 7.794  | -0.123 | -3.799   | -1.905   | -85.823  | -5.000  |
| -5.426  | 9.236  | -0.138 | -4.476   | -2.282   | -103.785 | -6.000  |
| -5.962  | 10.779 | -0.148 | -5.340   | -2.705   | -121.931 | -7.000  |
| -6.863  | 12.783 | -0.171 | -6.035   | -3.054   | -139.943 | -8.000  |
| -7.750  | 13.969 | -0.189 | -6.650   | -3.531   | -158.430 | -9.000  |
| -9.176  | 14.954 | -0.202 | -7.712   | -3.891   | -176.471 | -10.000 |
| -10.108 | 17.002 | -0.219 | -8.475   | -4.268   | -193.887 | -11.000 |
| -10.618 | 18.142 | -0.239 | -9.073   | -4.682   | -212.924 | -12.000 |
| -11.172 | 20.122 | -0.260 | -9.915   | -5.074   | -232.423 | -13.000 |
| -12.466 | 21.659 | -0.268 | -10.695  | -5.559   | -250.647 | -14.000 |
| -14.763 | 22.990 | -0.273 | -11.271  | -5.905   | -268.582 | -15.000 |
| -15.194 | 24.511 | -0.302 | -12.181  | -6.299   | -287.888 | -16.000 |
| -15.222 | 26.181 | -0.311 | -12.977  | -6.741   | -306.602 | -17.000 |
| -17.686 | 28.042 | -0.342 | -13.536  | -7.032   | -326.103 | -18.000 |
| -18.451 | 29.447 | -0.347 | -14.373  | -7.589   | -345.674 | -19.000 |
| -18.887 | 30.984 | -0.362 | -15.017  | -8.085   | -364.848 | -20.000 |
| -18.320 | 29.603 | -0.343 | -14.438  | -7.639   | -346.843 | -19.000 |
| -17.685 | 28.028 | -0.324 | -13.515  | -7.074   | -327.285 | -18.000 |
| -16.401 | 26.287 | -0.315 | -13.016  | -6.726   | -308.430 | -17.000 |
| -14.732 | 24.678 | -0.291 | -12.307  | -6.352   | -288.934 | -16.000 |
| -14.621 | 23.082 | -0.275 | -11.367  | -5.954   | -269.874 | -15.000 |
| -13.548 | 21.942 | -0.260 | -10.647  | -5.516   | -250.898 | -14.000 |
| -11.538 | 20.193 | -0.238 | -9.848   | -5.233   | -231.718 | -13.000 |
| -11.140 | 18.221 | -0.231 | -9.298   | -4.807   | -213.766 | -12.000 |

Table B.3 Loading for Negative Lift



| L<br>LBS. | D<br>LBS. | Y<br>LBS. | PM<br>IN.-LBS. | YM<br>IN.-LBS. | RM<br>IN.-LBS. | LOADS<br>LBS. |
|-----------|-----------|-----------|----------------|----------------|----------------|---------------|
| -9.829    | 17.183    | -0.220    | -8.528         | -4.345         | -195.012       | -11.000       |
| -8.389    | 15.609    | -0.189    | -7.825         | -3.871         | -177.525       | -10.000       |
| -8.427    | 13.805    | -0.174    | -6.761         | -3.560         | -158.393       | -9.000        |
| -7.429    | 12.775    | -0.162    | -6.053         | -3.159         | -140.009       | -8.000        |
| -6.237    | 10.903    | -0.149    | -5.317         | -2.765         | -122.401       | -7.000        |
| -5.430    | 9.379     | -0.121    | -4.467         | -2.350         | -104.339       | -6.000        |
| -4.382    | 7.697     | -0.111    | -3.946         | -2.049         | -86.772        | -5.000        |
| -3.342    | 6.110     | -0.082    | -3.249         | -1.605         | -68.951        | -4.000        |
| -3.271    | 4.588     | -0.066    | -2.276         | -1.175         | -52.168        | -3.000        |
| -2.342    | 3.567     | -0.055    | -1.613         | -0.789         | -33.987        | -2.000        |
| -0.866    | 1.625     | -0.045    | -1.019         | -0.454         | -16.524        | -1.000        |
| -0.320    | 0.100     | -0.017    | 0.045          | -0.035         | 0.706          | 0.000         |

Table B.3 (cont.)

| L<br>LBS. | D<br>LBS. | Y<br>LBS. | PM<br>IN.-LBS. | YM<br>IN.-LBS. | RM<br>IN.-LBS. | LOADS<br>LBS. |
|-----------|-----------|-----------|----------------|----------------|----------------|---------------|
| 0.144     | 0.064     | -0.016    | 0.038          | 0.000          | -0.213         | 0.000         |
| 0.103     | 1.435     | -0.041    | 0.027          | -0.269         | 0.227          | 1.000         |
| 0.063     | 2.570     | -0.054    | 0.093          | -0.322         | 0.109          | 2.000         |
| 0.088     | 3.640     | -0.037    | 0.187          | 0.019          | 0.442          | 3.000         |
| -0.409    | 4.079     | -0.064    | 0.076          | -0.263         | 0.363          | 4.000         |
| -0.607    | 4.972     | -0.066    | -0.006         | -0.318         | 0.644          | 5.000         |
| -0.818    | 5.636     | -0.080    | 0.013          | -0.466         | 1.058          | 6.000         |
| -1.108    | 6.678     | -0.089    | 0.003          | -0.640         | 1.445          | 7.000         |
| -1.813    | 9.358     | -0.154    | -0.270         | -1.701         | 1.871          | 8.000         |
| -1.866    | 9.969     | -0.153    | -0.504         | -1.907         | 2.325          | 9.000         |
| -2.733    | 10.906    | -0.173    | -0.326         | -2.143         | 2.299          | 10.000        |
| -4.186    | 11.435    | -0.170    | -0.430         | -2.392         | 2.327          | 11.000        |
| -4.579    | 12.786    | -0.189    | -0.625         | -2.617         | 3.325          | 12.000        |
| -4.202    | 13.594    | -0.164    | -0.792         | -2.862         | 3.698          | 13.000        |
| -4.849    | 14.810    | -0.198    | -1.071         | -3.161         | 3.726          | 14.000        |
| -4.640    | 15.565    | -0.178    | -0.995         | -3.176         | 4.644          | 15.000        |
| -4.720    | 16.652    | -0.196    | -1.206         | -3.442         | 5.416          | 16.000        |
| -5.129    | 17.627    | -0.209    | -1.310         | -3.709         | 5.589          | 17.000        |
| -5.186    | 18.299    | -0.186    | -1.285         | -3.797         | 4.722          | 18.000        |
| -5.685    | 19.090    | -0.209    | -1.344         | -4.120         | 5.255          | 19.000        |
| -6.112    | 20.784    | -0.211    | -1.392         | -4.351         | 5.452          | 20.000        |
| -5.701    | 19.611    | -0.226    | -1.299         | -4.143         | 5.224          | 19.000        |
| -5.305    | 18.604    | -0.230    | -1.330         | -3.984         | 5.608          | 18.000        |
| -5.020    | 18.090    | -0.221    | -1.304         | -3.826         | 5.542          | 17.000        |
| -4.171    | 17.036    | -0.224    | -1.143         | -3.464         | 5.131          | 16.000        |
| -4.431    | 15.455    | -0.190    | -1.055         | -3.137         | 4.508          | 15.000        |
| -4.536    | 14.847    | -0.219    | -0.928         | -3.045         | 3.552          | 14.000        |
| -4.689    | 14.038    | -0.231    | -0.874         | -2.962         | 3.460          | 13.000        |
| -4.359    | 12.790    | -0.200    | -0.651         | -2.715         | 2.729          | 12.000        |

Table B.4 Loading for Positive Drag

| L      | D      | Y      | PM       | YM       | RM       | LOADS  |
|--------|--------|--------|----------|----------|----------|--------|
| LBS.   | LBS.   | LBS.   | IN.-LBS. | IN.-LBS. | IN.-LBS. | LBS.   |
| -3.948 | 11.490 | -0.184 | -0.309   | -2.289   | 2.717    | 11.000 |
| -3.196 | 10.758 | -0.178 | -0.205   | -2.100   | 2.598    | 10.000 |
| -2.793 | 9.849  | -0.170 | -0.168   | -1.835   | 2.613    | 9.000  |
| -2.011 | 8.958  | -0.156 | -0.114   | -1.686   | 1.842    | 8.000  |
| -1.308 | 7.860  | -0.139 | -0.139   | -1.442   | 0.818    | 7.000  |
| -1.224 | 6.379  | -0.119 | -0.026   | -1.155   | 0.992    | 6.000  |
| -1.152 | 5.406  | -0.120 | 0.018    | -1.046   | 0.674    | 5.000  |
| -1.047 | 4.629  | -0.107 | 0.054    | -0.826   | -0.111   | 4.000  |
| -0.603 | 3.881  | -0.075 | 0.090    | -0.573   | -0.176   | 3.000  |
| -0.330 | 2.591  | -0.059 | 0.206    | -0.300   | -0.188   | 2.000  |
| 0.118  | 1.637  | -0.048 | 0.073    | -0.116   | -0.347   | 1.000  |
| 0.144  | 0.064  | -0.016 | 0.038    | 0.000    | -0.213   | 0.000  |

Table B.4 (cont.)

| L      | D       | Y     | PM       | YM       | RM       | LOADS   |
|--------|---------|-------|----------|----------|----------|---------|
| LBS.   | LBS.    | LBS.  | IN.-LBS. | IN.-LBS. | IN.-LBS. | LBS.    |
| -0.047 | 0.128   | 0.003 | 0.021    | -0.055   | 0.105    | 0.000   |
| -0.268 | -0.546  | 0.007 | -0.527   | -0.209   | 1.577    | -1.000  |
| -0.376 | -1.706  | 0.010 | -0.856   | -0.241   | 2.934    | -2.000  |
| -0.259 | -2.447  | 0.016 | -0.987   | -0.256   | 4.103    | -3.000  |
| -0.334 | -3.405  | 0.004 | -1.084   | -0.304   | 5.706    | -4.000  |
| 0.059  | -4.182  | 0.007 | -1.097   | -0.211   | 6.613    | -5.000  |
| 0.028  | -5.573  | 0.010 | -1.143   | -0.250   | 8.271    | -6.000  |
| 0.271  | -6.284  | 0.016 | -1.234   | -0.194   | 10.216   | -7.000  |
| 0.252  | -7.019  | 0.010 | -1.563   | -0.178   | 11.656   | -8.000  |
| 0.292  | -7.862  | 0.011 | -1.847   | -0.193   | 13.351   | -9.000  |
| 0.428  | -9.494  | 0.023 | -1.803   | 0.156    | 14.560   | -10.000 |
| 0.445  | -10.430 | 0.020 | -2.081   | 0.066    | 15.356   | -11.000 |
| 0.700  | -11.191 | 0.013 | -2.252   | 0.031    | 17.417   | -12.000 |
| 0.895  | -12.043 | 0.022 | -2.321   | 0.188    | 18.810   | -13.000 |
| 1.103  | -13.295 | 0.028 | -2.413   | 0.316    | 20.268   | -14.000 |
| 1.036  | -14.414 | 0.022 | -2.561   | 0.281    | 21.610   | -15.000 |
| 1.507  | -15.153 | 0.026 | -2.805   | 0.372    | 22.911   | -16.000 |
| 1.392  | -16.192 | 0.019 | -3.038   | 0.460    | 24.032   | -17.000 |
| 2.057  | -17.759 | 0.021 | -3.084   | 0.658    | 25.901   | -18.000 |
| 2.038  | -18.552 | 0.034 | -3.238   | 0.573    | 27.110   | -19.000 |
| 1.611  | -18.979 | 0.030 | -3.363   | 0.356    | 28.736   | -20.000 |
| 1.627  | -18.488 | 0.027 | -3.308   | 0.508    | 27.292   | -19.000 |
| 1.692  | -17.609 | 0.030 | -3.106   | 0.518    | 25.689   | -18.000 |
| 1.757  | -16.764 | 0.023 | -2.835   | 0.592    | 23.895   | -17.000 |
| 1.882  | -15.817 | 0.024 | -2.509   | 0.631    | 22.722   | -16.000 |
| 1.971  | -15.061 | 0.023 | -2.351   | 0.867    | 21.581   | -15.000 |
| 1.531  | -13.449 | 0.024 | -2.477   | 0.308    | 20.197   | -14.000 |
| 1.392  | -12.477 | 0.022 | -2.359   | 0.343    | 18.803   | -13.000 |
| 1.613  | -11.454 | 0.016 | -2.163   | 0.416    | 17.453   | -12.000 |

Table B.5 Loading For Negative Drag



| L<br>LBS. | D<br>LBS. | Y<br>LBS. | PM<br>IN.-LBS. | YM<br>IN.-LBS. | RM<br>IN.-LBS. | LOADS<br>LBS. |
|-----------|-----------|-----------|----------------|----------------|----------------|---------------|
| 1.175     | -10.663   | 0.021     | -1.892         | 0.291          | 15.265         | -11.000       |
| 1.551     | -9.766    | 0.011     | -1.656         | 0.388          | 14.555         | -10.000       |
| 0.874     | -8.346    | 0.016     | -1.697         | -0.193         | 13.526         | -9.000        |
| 1.070     | -7.236    | 0.023     | -1.297         | -0.056         | 11.567         | -8.000        |
| 1.074     | -6.647    | 0.007     | -1.156         | 0.005          | 10.181         | -7.000        |
| 0.948     | -5.541    | 0.011     | -1.158         | -0.295         | 8.384          | -6.000        |
| 1.084     | -4.263    | 0.004     | -1.046         | -0.018         | 7.275          | -5.000        |
| 0.611     | -3.582    | 0.001     | -0.860         | -0.185         | 6.052          | -4.000        |
| 0.807     | -2.663    | 0.009     | -0.675         | -0.180         | 4.407          | -3.000        |
| 0.526     | -1.796    | 0.017     | -0.354         | -0.274         | 3.091          | -2.000        |
| 0.019     | -0.502    | 0.003     | -0.055         | -0.192         | 1.860          | -1.000        |
| -0.047    | 0.128     | 0.003     | 0.021          | -0.055         | 0.105          | 0.000         |

Table B.5 (cont.)

| L       | D      | Y      | PM       | YM       | RM       | LOADS  |
|---------|--------|--------|----------|----------|----------|--------|
| LBS.    | LBS.   | LBS.   | IN.-LBS. | IN.-LBS. | IN.-LBS. | LBS.   |
| 0.166   | 0.100  | 0.002  | 0.008    | -0.008   | 0.120    | 0.000  |
| -2.221  | 1.450  | 0.952  | -1.108   | -3.126   | 2.045    | 1.000  |
| -4.584  | 2.770  | 1.958  | -2.031   | -6.398   | 4.872    | 2.000  |
| -8.008  | 4.316  | 2.973  | -3.360   | -9.619   | 6.369    | 3.000  |
| -10.188 | 5.473  | 3.961  | -4.005   | -12.859  | 8.063    | 4.000  |
| -12.156 | 7.485  | 4.940  | -4.961   | -16.118  | 9.770    | 5.000  |
| -14.632 | 9.098  | 5.946  | -5.618   | -19.031  | 11.992   | 6.000  |
| -17.930 | 10.452 | 6.936  | -6.462   | -22.242  | 14.249   | 7.000  |
| -21.630 | 12.019 | 7.931  | -7.644   | -25.453  | 16.619   | 8.000  |
| -24.214 | 13.765 | 8.974  | -8.448   | -28.676  | 18.883   | 9.000  |
| -27.802 | 15.002 | 9.941  | -9.427   | -31.652  | 19.868   | 10.000 |
| -30.794 | 16.649 | 10.888 | -10.068  | -34.573  | 21.895   | 11.000 |
| -34.323 | 18.084 | 11.901 | -11.239  | -37.945  | 24.728   | 12.000 |
| -37.631 | 19.661 | 12.847 | -12.372  | -40.886  | 26.277   | 13.000 |
| -41.456 | 21.630 | 13.835 | -13.000  | -43.932  | 28.876   | 14.000 |
| -47.040 | 23.856 | 14.861 | -14.416  | -47.777  | 30.882   | 15.000 |
| -50.053 | 25.205 | 15.802 | -14.841  | -50.103  | 34.085   | 16.000 |
| -52.008 | 26.471 | 16.799 | -15.510  | -53.119  | 36.597   | 17.000 |
| -58.790 | 28.820 | 17.783 | -16.971  | -56.886  | 38.280   | 18.000 |
| -62.650 | 30.278 | 18.755 | -17.679  | -59.750  | 40.188   | 19.000 |
| -65.594 | 31.940 | 19.738 | -18.501  | -62.337  | 43.755   | 20.000 |
| -64.978 | 31.710 | 19.477 | -18.377  | -61.613  | 42.953   | 19.000 |
| -59.463 | 28.995 | 17.908 | -16.992  | -57.049  | 39.051   | 18.000 |
| -55.590 | 28.391 | 17.480 | -16.207  | -55.472  | 38.018   | 17.000 |
| -50.338 | 24.991 | 15.904 | -14.850  | -50.364  | 34.373   | 16.000 |
| -48.193 | 24.032 | 15.467 | -14.518  | -49.057  | 33.498   | 15.000 |
| -41.215 | 21.817 | 13.916 | -13.116  | -44.146  | 29.675   | 14.000 |
| -37.583 | 20.231 | 12.990 | -12.591  | -41.367  | 27.194   | 13.000 |
| -36.297 | 18.948 | 12.194 | -11.421  | -39.036  | 25.729   | 12.000 |

Table B.6 Loading for Positive Yaw

| L<br>LBS. | D<br>LBS. | Y<br>LBS. | PM<br>IN.-LBS. | YM<br>IN.-LBS. | RM<br>IN.-LBS. | LOADS<br>LBS. |
|-----------|-----------|-----------|----------------|----------------|----------------|---------------|
| -31.183   | 17.109    | 11.073    | -10.167        | -35.216        | 23.473         | 11.000        |
| -27.492   | 15.307    | 10.141    | -9.484         | -31.984        | 21.584         | 10.000        |
| -23.788   | 13.713    | 9.022     | -8.394         | -28.689        | 18.667         | 9.000         |
| -21.227   | 11.942    | 8.038     | -7.564         | -25.422        | 16.641         | 8.000         |
| -17.927   | 10.710    | 7.143     | -6.711         | -22.570        | 14.574         | 7.000         |
| -14.556   | 9.361     | 6.044     | -5.639         | -19.039        | 12.346         | 6.000         |
| -12.173   | 7.227     | 5.092     | -4.848         | -15.843        | 10.535         | 5.000         |
| -9.954    | 5.821     | 3.997     | -3.934         | -12.944        | 8.368          | 4.000         |
| -7.879    | 4.408     | 3.005     | -3.093         | -9.650         | 6.769          | 3.000         |
| -4.531    | 3.227     | 2.051     | -1.970         | -6.483         | 4.986          | 2.000         |
| -2.098    | 1.751     | 0.977     | -1.027         | -3.179         | 2.248          | 1.000         |
| 0.166     | 0.100     | 0.002     | 0.008          | -0.008         | 0.120          | 0.000         |

Table B.6 (cont.)

| L      | D       | Y       | PM       | YM       | RM       | LOADS   |
|--------|---------|---------|----------|----------|----------|---------|
| LBS.   | LBS.    | LBS.    | IN.-LBS. | IN.-LBS. | IN.-LBS. | LBS.    |
| -0.055 | 0.059   | 0.001   | 0.063    | 0.011    | 0.093    | 0.000   |
| 2.967  | -1.059  | -0.958  | 0.814    | 2.800    | -1.335   | -1.000  |
| 5.120  | -3.017  | -1.967  | 1.483    | 5.865    | -3.260   | -2.000  |
| 9.351  | -3.996  | -2.962  | 2.289    | 8.951    | -5.569   | -3.000  |
| 12.379 | -5.175  | -4.004  | 2.978    | 12.092   | -6.474   | -4.000  |
| 15.312 | -6.789  | -5.002  | 3.835    | 15.341   | -7.712   | -5.000  |
| 18.821 | -8.044  | -5.984  | 4.533    | 18.385   | -8.733   | -6.000  |
| 22.298 | -10.201 | -6.985  | 5.425    | 21.697   | -10.471  | -7.000  |
| 25.668 | -11.360 | -8.079  | 6.394    | 25.109   | -12.095  | -8.000  |
| 30.029 | -12.708 | -9.029  | 7.141    | 28.223   | -13.451  | -9.000  |
| 33.394 | -14.695 | -10.008 | 7.938    | 31.286   | -14.795  | -10.000 |
| 37.067 | -15.702 | -10.882 | 8.985    | 34.161   | -15.909  | -11.000 |
| 40.183 | -17.035 | -11.851 | 9.548    | 37.032   | -17.473  | -12.000 |
| 43.295 | -18.697 | -12.867 | 10.347   | 40.414   | -18.254  | -13.000 |
| 48.918 | -19.892 | -13.817 | 11.280   | 43.732   | -19.292  | -14.000 |
| 52.645 | -21.816 | -14.834 | 12.138   | 46.734   | -21.012  | -15.000 |
| 56.876 | -23.024 | -15.921 | 13.090   | 49.950   | -22.206  | -16.000 |
| 61.506 | -25.086 | -16.906 | 14.010   | 53.449   | -23.491  | -17.000 |
| 66.405 | -26.855 | -18.014 | 15.040   | 57.019   | -25.279  | -18.000 |
| 69.930 | -28.047 | -18.886 | 16.051   | 59.726   | -25.959  | -19.000 |
| 74.306 | -30.189 | -19.884 | 16.967   | 63.041   | -26.666  | -20.000 |
| 70.803 | -28.908 | -19.095 | 16.286   | 60.537   | -26.031  | -19.000 |
| 68.264 | -27.218 | -18.107 | 15.610   | 57.885   | -24.959  | -18.000 |
| 62.162 | -25.538 | -16.925 | 14.443   | 54.100   | -23.205  | -17.000 |
| 58.846 | -24.198 | -16.093 | 13.560   | 51.431   | -22.340  | -16.000 |
| 52.757 | -22.058 | -14.995 | 12.463   | 47.182   | -21.090  | -15.000 |
| 49.430 | -20.316 | -13.840 | 11.546   | 44.132   | -19.248  | -14.000 |
| 43.593 | -18.641 | -12.946 | 10.558   | 40.542   | -18.102  | -13.000 |
| 40.778 | -17.547 | -11.946 | 9.856    | 37.670   | -16.751  | -12.000 |

Table B.7 Loading for Negative Yaw



| L      | D       | Y       | PM       | YM       | RM       | LOADS   |
|--------|---------|---------|----------|----------|----------|---------|
| LBS.   | LBS.    | LBS.    | IN.-LBS. | IN.-LBS. | IN.-LBS. | LBS.    |
| 37.661 | -15.865 | -11.075 | 9.213    | 34.940   | -15.773  | -11.000 |
| 34.570 | -14.791 | -10.072 | 8.389    | 31.824   | -14.770  | -10.000 |
| 29.287 | -12.187 | -8.955  | 7.083    | 27.878   | -13.305  | -9.000  |
| 26.086 | -11.401 | -8.010  | 6.463    | 25.056   | -12.264  | -8.000  |
| 21.526 | -9.723  | -7.075  | 5.484    | 21.682   | -10.212  | -7.000  |
| 18.626 | -7.830  | -6.014  | 4.813    | 18.554   | -8.891   | -6.000  |
| 15.819 | -6.804  | -5.069  | 4.066    | 15.600   | -7.661   | -5.000  |
| 12.420 | -5.390  | -4.040  | 3.138    | 12.376   | -6.073   | -4.000  |
| 9.107  | -3.991  | -3.046  | 2.599    | 9.184    | -5.048   | -3.000  |
| 5.517  | -2.901  | -2.037  | 1.799    | 6.175    | -3.386   | -2.000  |
| 2.913  | -1.042  | -0.996  | 0.887    | 3.049    | -1.494   | -1.000  |
| -0.055 | 0.059   | 0.001   | 0.063    | 0.011    | 0.093    | 0.000   |

Table B.7 (cont.)

| L       | D       | Y      | PM       | YM       | RM       | LOADS    |
|---------|---------|--------|----------|----------|----------|----------|
| LBS.    | LBS.    | LBS.   | IN.-LBS. | IN.-LBS. | IN.-LBS. | IN.-LBS. |
| 0.214   | 0.211   | -0.001 | -0.025   | -0.009   | 0.080    | 0.000    |
| 9.468   | 28.547  | -0.001 | 13.012   | 8.673    | -11.054  | 20.000   |
| 18.834  | 58.099  | -0.033 | 26.355   | 17.266   | -22.066  | 40.000   |
| 29.181  | 87.189  | -0.058 | 40.271   | 25.624   | -32.834  | 60.000   |
| 39.729  | 116.142 | -0.082 | 54.581   | 34.027   | -43.690  | 80.000   |
| 51.132  | 145.804 | -0.109 | 69.702   | 42.167   | -53.712  | 100.000  |
| 64.056  | 176.691 | -0.123 | 85.694   | 50.777   | -65.525  | 120.000  |
| 76.604  | 206.900 | -0.128 | 101.923  | 58.724   | -76.172  | 140.000  |
| 88.111  | 234.610 | -0.122 | 117.496  | 66.495   | -84.066  | 160.000  |
| 100.781 | 265.683 | -0.186 | 134.947  | 74.174   | -94.863  | 180.000  |
| 114.512 | 297.252 | -0.181 | 153.081  | 82.029   | -105.526 | 200.000  |
| 101.755 | 266.397 | -0.137 | 135.461  | 74.735   | -96.058  | 180.000  |
| 88.159  | 235.886 | -0.133 | 117.651  | 66.528   | -85.026  | 160.000  |
| 76.039  | 207.251 | -0.126 | 101.846  | 58.726   | -75.896  | 140.000  |
| 63.970  | 177.839 | -0.114 | 85.756   | 50.817   | -66.951  | 120.000  |
| 51.714  | 146.766 | -0.090 | 69.630   | 42.436   | -53.868  | 100.000  |
| 40.502  | 115.353 | -0.059 | 54.721   | 34.242   | -43.078  | 80.000   |
| 29.586  | 86.839  | -0.053 | 39.953   | 25.635   | -31.998  | 60.000   |
| 19.403  | 58.176  | -0.039 | 26.159   | 17.333   | -21.830  | 40.000   |
| 9.582   | 28.496  | -0.017 | 12.768   | 8.688    | -10.569  | 20.000   |
| 0.214   | 0.211   | -0.001 | -0.025   | -0.009   | 0.080    | 0.000    |

Table B.8 Loading for Positive Pitching Moment

| L        | D        | Y      | PM       | YM       | RM       | LOADS    |
|----------|----------|--------|----------|----------|----------|----------|
| LBS.     | LBS.     | LBS.   | IN.-LBS. | IN.-LBS. | IN.-LBS. | IN.-LBS. |
| -0.022   | 0.053    | -0.013 | -0.085   | 0.002    | 1.204    | 0.000    |
| -9.342   | -22.299  | -0.034 | -20.149  | -9.753   | 8.902    | -20.000  |
| -20.459  | -46.536  | 0.005  | -40.398  | -19.304  | 18.062   | -40.000  |
| -31.843  | -70.894  | -0.030 | -59.988  | -28.202  | 25.567   | -60.000  |
| -46.272  | -97.552  | -0.051 | -80.013  | -37.564  | 34.076   | -80.000  |
| -60.649  | -124.862 | -0.052 | -99.914  | -46.601  | 42.721   | -100.000 |
| -77.102  | -153.984 | -0.012 | -119.811 | -55.450  | 51.347   | -120.000 |
| -95.409  | -184.075 | -0.005 | -140.690 | -64.299  | 59.544   | -140.000 |
| -113.896 | -213.973 | -0.019 | -160.273 | -72.931  | 67.517   | -160.000 |
| -134.509 | -245.938 | -0.013 | -180.202 | -81.501  | 75.865   | -180.000 |
| -156.696 | -279.220 | -0.016 | -200.807 | -90.054  | 84.861   | -200.000 |
| -135.589 | -246.365 | 0.044  | -180.564 | -81.905  | 76.076   | -180.000 |
| -110.857 | -215.607 | -0.052 | -160.126 | -72.143  | 67.292   | -160.000 |
| -95.290  | -183.924 | 0.040  | -140.576 | -64.833  | 59.076   | -140.000 |
| -78.035  | -154.095 | -0.167 | -120.342 | -55.966  | 50.528   | -120.000 |
| -59.298  | -126.386 | -0.026 | -99.877  | -46.182  | 41.785   | -100.000 |
| -45.867  | -97.905  | -0.055 | -80.014  | -37.366  | 33.798   | -80.000  |
| -31.443  | -71.330  | -0.008 | -59.783  | -28.420  | 25.332   | -60.000  |
| -19.286  | -46.787  | -0.048 | -40.361  | -18.893  | 16.988   | -40.000  |
| -9.088   | -22.485  | -0.025 | -20.020  | -9.698   | 8.443    | -20.000  |
| -0.022   | 0.053    | -0.013 | -0.085   | 0.002    | 1.204    | 0.000    |

Table B.9 Loading for Negative Pitching Moment

| L      | D       | Y      | PM       | YM       | RM       | LOADS    |
|--------|---------|--------|----------|----------|----------|----------|
| LBS.   | LBS.    | LBS.   | IN.-LBS. | IN.-LBS. | IN.-LBS. | IN.-LBS. |
| 0.066  | -0.131  | -0.008 | 0.025    | -0.110   | 0.212    | 0.000    |
| 5.562  | -4.377  | 0.211  | 0.835    | 4.240    | 1.341    | 4.500    |
| 11.857 | -9.049  | 0.370  | 2.083    | 8.887    | 2.601    | 9.000    |
| 18.013 | -13.622 | 0.495  | 3.150    | 13.489   | 3.331    | 13.500   |
| 24.747 | -18.318 | 0.626  | 3.910    | 18.382   | 4.961    | 18.000   |
| 31.940 | -22.505 | 0.829  | 5.555    | 22.643   | 4.846    | 22.500   |
| 37.782 | -26.961 | 1.037  | 6.809    | 27.220   | 6.147    | 27.000   |
| 44.619 | -32.413 | 1.032  | 7.773    | 32.072   | 6.461    | 31.500   |
| 53.843 | -36.639 | 1.193  | 9.141    | 36.627   | 7.297    | 36.000   |
| 59.427 | -41.664 | 1.599  | 9.996    | 40.472   | 8.143    | 40.500   |
| 69.069 | -46.790 | 2.142  | 11.322   | 45.119   | 9.719    | 45.000   |
| 60.551 | -41.774 | 1.587  | 10.158   | 40.805   | 8.513    | 40.500   |
| 53.264 | -36.577 | 1.493  | 9.025    | 36.165   | 7.753    | 36.000   |
| 45.255 | -32.552 | 1.278  | 7.913    | 32.021   | 7.069    | 31.500   |
| 37.751 | -27.066 | 1.106  | 6.789    | 27.180   | 5.832    | 27.000   |
| 31.770 | -22.787 | 0.996  | 5.544    | 22.547   | 5.388    | 22.500   |
| 24.763 | -18.305 | 0.602  | 4.545    | 18.441   | 5.226    | 18.000   |
| 17.238 | -13.475 | 0.505  | 3.055    | 13.512   | 4.338    | 13.500   |
| 12.701 | -8.738  | 0.338  | 2.273    | 9.097    | 2.429    | 9.000    |
| 5.932  | -4.225  | 0.163  | 1.185    | 4.491    | 1.155    | 4.500    |
| 0.066  | -0.131  | -0.008 | 0.025    | -0.110   | 0.212    | 0.000    |

Table B.10 Loading for Positive Yawing Moment



| L<br>LBS. | D<br>LBS. | Y<br>LBS. | PM<br>IN.-LBS. | YM<br>IN.-LBS. | RM<br>IN.-LBS. | LOADS<br>IN.-LBS. |
|-----------|-----------|-----------|----------------|----------------|----------------|-------------------|
|           |           |           |                |                |                |                   |
| -0.364    | -0.032    | -0.028    | 0.028          | -0.027         | 0.781          | 0.000             |
| -4.753    | 4.450     | -0.176    | -1.317         | -4.459         | 1.095          | -4.500            |
| -9.841    | 9.326     | -0.366    | -2.934         | -8.975         | 1.589          | -9.000            |
| -14.898   | 13.985    | -0.540    | -4.137         | -13.347        | 2.262          | -13.500           |
| -20.846   | 18.948    | -0.759    | -5.256         | -18.131        | 2.682          | -18.000           |
| -27.429   | 23.529    | -0.905    | -6.851         | -22.375        | 3.800          | -22.500           |
| -33.057   | 28.182    | -0.931    | -8.447         | -26.892        | 4.200          | -27.000           |
| -41.042   | 33.270    | -0.940    | -9.815         | -31.754        | 4.779          | -31.500           |
| -48.163   | 38.046    | -1.406    | -11.161        | -35.695        | 4.987          | -36.000           |
| -56.084   | 42.681    | -1.179    | -12.434        | -40.492        | 6.500          | -40.500           |
| -63.355   | 47.777    | -1.296    | -13.990        | -44.956        | 6.613          | -45.000           |
| -55.843   | 42.721    | -1.134    | -12.621        | -40.644        | 6.260          | -40.500           |
| -48.025   | 38.026    | -1.340    | -11.161        | -35.826        | 5.420          | -36.000           |
| -40.568   | 33.183    | -1.021    | -9.776         | -31.786        | 4.654          | -31.500           |
| -32.476   | 28.313    | -0.984    | -8.537         | -26.865        | 4.089          | -27.000           |
| -26.527   | 23.464    | -0.671    | -6.919         | -22.446        | 3.769          | -22.500           |
| -20.665   | 18.716    | -0.714    | -5.330         | -18.099        | 3.247          | -18.000           |
| -15.310   | 14.012    | -0.561    | -4.251         | -13.569        | 2.482          | -13.500           |
| -9.742    | 9.281     | -0.337    | -2.996         | -9.067         | 2.204          | -9.000            |
| -4.863    | 4.281     | -0.192    | -1.549         | -4.485         | 1.514          | -4.500            |
| -0.364    | -0.032    | -0.028    | 0.028          | -0.027         | 0.781          | 0.000             |

Table B.11 Loading for Negative Yawing Moment

| L      | D       | Y      | PM       | YM       | RM       | LOADS    |
|--------|---------|--------|----------|----------|----------|----------|
| LBS.   | LBS.    | LBS.   | IN.-LBS. | IN.-LBS. | IN.-LBS. | IN.-LBS. |
| -0.261 | 0.082   | -0.012 | -0.141   | -0.062   | 0.683    | 0.000    |
| 2.400  | -0.977  | -0.017 | -1.133   | -0.787   | 12.072   | 11.500   |
| 5.066  | -2.106  | -0.098 | -2.068   | -1.360   | 23.143   | 23.000   |
| 7.477  | -3.170  | -0.113 | -3.123   | -2.272   | 34.326   | 34.500   |
| 10.411 | -4.364  | -0.166 | -4.087   | -2.780   | 47.042   | 46.000   |
| 12.944 | -5.136  | -0.225 | -4.966   | -3.525   | 57.242   | 57.500   |
| 16.316 | -6.254  | -0.233 | -5.749   | -4.195   | 68.583   | 69.000   |
| 19.773 | -7.130  | -0.317 | -6.933   | -4.964   | 80.292   | 80.500   |
| 22.995 | -8.211  | -0.303 | -7.909   | -5.483   | 93.388   | 92.000   |
| 26.416 | -9.415  | -0.308 | -9.060   | -6.342   | 104.096  | 103.500  |
| 29.380 | -10.585 | -0.388 | -9.725   | -6.723   | 115.821  | 115.000  |
| 26.436 | -9.063  | -0.308 | -9.225   | -6.460   | 102.672  | 103.500  |
| 22.941 | -7.841  | -0.417 | -7.918   | -5.679   | 91.494   | 92.000   |
| 20.190 | -6.985  | -0.274 | -7.125   | -5.156   | 78.468   | 80.500   |
| 16.915 | -6.002  | -0.260 | -5.547   | -4.083   | 68.825   | 69.000   |
| 14.206 | -5.466  | -0.241 | -5.042   | -3.244   | 56.446   | 57.500   |
| 10.928 | -3.948  | -0.176 | -4.108   | -2.717   | 46.912   | 46.000   |
| 8.552  | -3.227  | -0.136 | -3.055   | -2.002   | 35.616   | 34.500   |
| 4.663  | -2.367  | -0.098 | -2.280   | -1.340   | 23.271   | 23.000   |
| 2.454  | -1.191  | -0.033 | -1.165   | -0.711   | 12.422   | 11.500   |
| -0.261 | 0.082   | -0.012 | -0.141   | -0.062   | 0.683    | 0.000    |

Table B.12 Loading for Positive Rolling Moment

| L<br>LBS. | D<br>LBS. | Y<br>LBS. | PM<br>IN.-LBS. | YM<br>IN.-LBS. | RM<br>IN.-LBS. | LOADS<br>IN.-LBS. |
|-----------|-----------|-----------|----------------|----------------|----------------|-------------------|
|           |           |           |                |                |                |                   |
| -0.188    | 0.053     | -0.005    | -0.023         | -0.024         | 0.210          | 0.000             |
| -2.414    | 0.822     | 0.022     | 0.818          | 0.688          | -10.239        | -11.500           |
| -5.413    | 1.281     | 0.050     | 1.275          | 1.289          | -22.723        | -23.000           |
| -7.829    | 2.468     | 0.068     | 2.224          | 1.917          | -34.816        | -34.500           |
| -10.429   | 3.520     | 0.084     | 2.837          | 2.760          | -45.299        | -46.000           |
| -14.950   | 3.991     | 0.245     | 3.540          | 3.525          | -57.070        | -57.500           |
| -17.179   | 4.586     | 0.102     | 4.271          | 4.225          | -68.102        | -69.000           |
| -20.313   | 5.433     | 0.136     | 5.085          | 4.988          | -79.611        | -80.500           |
| -23.743   | 6.551     | 0.161     | 5.967          | 5.424          | -91.562        | -92.000           |
| -26.884   | 7.181     | 0.195     | 6.562          | 6.349          | -102.372       | -103.500          |
| -31.111   | 8.611     | 0.286     | 7.206          | 6.775          | -113.554       | -115.000          |
| -27.668   | 7.449     | 0.315     | 6.546          | 6.124          | -105.360       | -103.500          |
| -23.715   | 6.705     | 0.242     | 6.022          | 5.623          | -94.574        | -92.000           |
| -20.660   | 5.896     | 0.214     | 5.060          | 4.659          | -82.659        | -80.500           |
| -18.021   | 5.410     | 0.064     | 4.261          | 4.069          | -71.081        | -69.000           |
| -14.706   | 4.519     | 0.125     | 3.446          | 3.421          | -60.337        | -57.500           |
| -10.793   | 3.840     | 0.120     | 2.945          | 2.816          | -46.204        | -46.000           |
| -8.334    | 2.809     | 0.094     | 2.160          | 2.114          | -34.994        | -34.500           |
| -5.582    | 1.321     | 0.016     | 1.432          | 1.450          | -22.390        | -23.000           |
| -3.077    | 0.825     | 0.015     | 0.800          | 0.792          | -12.264        | -11.500           |
| -0.188    | 0.053     | -0.005    | -0.023         | -0.024         | 0.210          | 0.000             |

Table B.13 Loading for Negative Rolling Moment

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